BULLETIN

OF

ENTOMOLOGICAL RESEARCH

ISSUED BY THE IMPERIAL
BUREAU OF ENTOMOLOGY.

EDITOR: THE DIRECTOR.

VOL. IV.

LONDON:

SOLD BY

DULAU & Co., LTD., 37, SOHO SQUARE, W.

1913-1914.

IMPERIAL BUREAU OF ENTOMOLOGY.

Head Office.—British Museum (Natural History), Cromwell Road, London, S.W.
Publication Office.—27, Elvaston Place, London, S.W.

CONTENTS.

ORIGINAL ARTICLES.

(C33) Wt. P.8/63. 1000. 7.14. B.&F.Ltd. Gp.11/1.

MISCELLANEOUS.

PLATES.

MAPS.

ILLUSTRATIONS IN THE TEXT.

eastern or Patigi, and the southern or Offa divisions. These are known respectively as divisions 1, 2 and 3, and each in its turn is sub-divided into a number of districts.

Dr. J. D. Falconer in his "Geology and Geography of Northern Nigeria" thus describes the orographical features of the province :—"The primary watershed of the Niger basin which runs from Kabba to Aiedi and thence westward a few miles south of the Ilorin frontier, is not defined by any range of hills or mountains, but by the crest line of a lofty plain which, like a low, extended arch, slopes gently northwards towards the Niger."* Across this plain six rivers—the Weru, Anwa, Oshin, Oyi, Oro and Kampe—run in an approximately parallel direction northward to flow into the Niger. The ultimate courses of the first two are doubtful and it is probable that before reaching the Niger they join in the manner indicated on the map.

"To the west, Ogga [in Kabba] and Eri are set within a cluster of rocky hills, while to the north there is a comparatively rapid fall to the plains of the Kampi. Between the Kampi and the Niger a steep-sided range of sandstone hills, capped by the pinnacle peaks of Egbom, runs out westward in a succession of rounded ridges two hundred feet above the level of the river, and not until near Share is the river belt of sandstones again bounded by a low escarpment. The Shappa and Orissa Hills form the only prominent range in central Ilorin. The Shappa Hills are of granite, and many of the peaks are gracefully rounded and most picturesque, while the quartzites and gneisses of the Orissa Hills give more rugged and irregular contours. West of the Orissa Hills lies the great plain of Ilorin, thickly populated and well cultivated, in broad undulations trending generally north and south, with scattered inselberge and many kopjes of granite boulders, but with no conspicuous ranges or groups of hills. The Jebba Hills, which extend southward for some distance towards Ilorin, pass westward into an extensive tract of hilly country, high-lying, little known and largely uninhabited, which forms a natural boundary between Ilorin and Borgu."†

The types of scenery are fairly represented by the photographs reproduced in this article to illustrate the haunts of various species of tsetse-flies. Dr. Falconer summarises their characteristics as follows :—"In Kabba, Ilorin, and Borgu, where crystalline rocks of a granitic or gneissic character cover by far the larger part of the surface, the prevailing and most characteristic type of scenery is that of rolling sandy plains with isolated hills or groups of hills rising abruptly above the general level. On the other hand, where sedimentary rocks, such as sandstones and ironstones, cover the surface, as in the river belt of sandstones in Kabba and Ilorin, the characteristic type of scenery is that of steep-sided and flat-topped ranges and plateaux, with detached tabular and conical hills rising from the lower plains."‡

Throughout the greater part of the province the vegetation is open bush, scattered with hardy trees that are able to withstand the annual bush-fires. The country occupying the whole of the central part of Ilorin may be described generally as undulating park-like land, well-farmed and dotted with trees, with

* Geology and Geography of Northern Nigeria, 1911, p. 16.

† J D. Falconer, Geology and Geography of Northern Nigeria, p. 18–19. ‡ *Op. cit.* p. 20–21

THE DISTRIBUTION OF GLOSSINA IN THE ILORIN PROVINCE OF NORTHERN NIGERIA.

By Dr. J. W. Scott Macfie, M.A.,
West African Medical Service.

(Plates I—VII and Map.)

With the rapid development of Northern Nigeria, following the British administration and the completion of the railway from Lagos to Kano, problems hitherto of minor importance are continually coming into prominence. Amongst these the abatement of trypanosomiasis is a matter of medical and entomological interest. As the confidence of the people grows there is an increase of intercommunication, which inevitably involves a danger of the spread of such diseases as sleeping sickness from existing foci. In Northern Nigeria these foci are at present peculiarly isolated, but they will gradually lose their isolation as the efforts made to stimulate the agricultural development of the country meet with greater success and the growing demand for roads, feeders for the railway, and better means of transport, is satisfied. In a densely populated and naturally fertile country like Ilorin the problem of avoiding this danger is particularly insistent, but unfortunately also particularly difficult. In the neighbouring province of Kabba sleeping sickness is said to be endemic, and might readily move westwards with the opening up of the interior ; and in a large part of the province of Ilorin itself tsetse-flies already spread disease amongst the cattle and horses to such an extent that these animals cannot live. Nevertheless, during the dry season, herds of cattle pass, day after day, in an almost continuous stream along the highroads on their way to Lagos from the north. How many die on the journey no one can tell, for the fate of those that sicken is to be butchered by the way, and it is a common experience to come across a carcase hewn up and laid out for sale by the road-side (Pl. I, fig. 1).

The first step towards discovering some remedy for this waste of cattle and horses, and some means of opening up the country safely, would seem to be an adequate study of the distribution of the carriers of the disease, the tsetse-flies ; and it was with this object that, on being appointed to Ilorin in February 1912, I undertook to make a systematic survey of the province.

Physical Features of Ilorin Province.

The Province of Ilorin, which is estimated to contain some 6,300 square miles and supports a population of perhaps half a million of people, forms part of the south-westerly portion of Northern Nigeria. The greater part of the province lies in the area enclosed by the eighth and ninth parallels of latitude and the longitudes 4° and 6° E. On the north it is bounded by the River Niger and the province of Borgu, on the south and west by Southern Nigeria, and on the east by the province of Kabba. It is divided into three sections, the western, the

(29262—2) Wt. P 11—21. 1000. 6/13. D & S. A

only occasional patches of bush, and thin belts of trees along the banks of the streams. Dense forest-belts occur, however, in the low-lying strips of swamp near the edge of the Niger valley, in the neighbourhood of the Kampe River, in the south-eastern corner of the province, and along the southern boundary as far west as Offa.

On the whole, the province is thickly populated, but there are in the eastern division two districts which are almost entirely uninhabited, the one lying between the rivers Oyi and Kampe, and the other across the Kampe towards Kabba. These districts, which had been depleted of their inhabitants by slave-raiders, are gradually being reoccupied. The north-western portion of the province is also very sparsely populated.

Game is scarce in the more densely populated districts. In the east and the south-east, however, hartebeeste, roan, cob, bushbuck, and duiker occur in fair numbers, and a few waterbuck, reedbuck, and buffalo. Game is also fairly plentiful to the north-west of the River Weru, around Jebba, and in some parts of Shari district.

Climate and Rainfall.

As the distribution of tsetse-flies is intimately associated with the meteorological conditions, a few words must be said about the climate of Ilorin. For this purpose I reproduce below the table of observations for the year 1909 as published in the official Gazette. This year has been selected because it is the latest in which continuous records have been returned for the whole twelve months.

Meteorological Record, Ilorin, 1909.

—	Temperature.				Rainfall.		Wind.
	Shade Maximum.	Shade Minimum.	Range.	Mean.	Amount in inches.	Degree of Humidity.	
January	97	53	44	79.5	.79	65	W.
February... ...	99	71	28	84	1.18	69	W.
March	98	68	30	83.9	5.30	71	S.W.
April	100	67	33	82.3	7.78	76	S.W.
May	98	68	30	81.8	7.12	78	S.W.
June	94	66	28	80.2	8.32	81	S.W.
July	92	67	25	77.3	9.49	81	S.W.
August	92	68	24	77.7	4.92	82	W.
September ...	90	67	23	78.1	14.12	82	S.W.
October	95	65	30	80.3	4.74	82	S.W.
November ...	99	66	33	81.8	.23	70	W.
December ...	102	52	50	78.3	1.19	65	W.
Averages and Totals.	96.3	64.8	31.5	80.4	65.18	75	S.W.

From an examination of this table it will be seen that the climate of Ilorin is humid and equable. The extremes of temperature for the year quoted were 102° F. and 52° F., whilst the mean was 80° F.; the average degree of humidity

was 75, and the rainfall, 65.18 inches, was one of the highest recorded in Northern Nigeria. The province of Ilorin, as might be expected from its geographical position, differs in climate to a marked extent from the more northerly regions. For example, in the greater part of Northern Nigeria the rainfall and temperature curves show only one annual maximum and minimum. In Ilorin, however, the temperature curve tends to show a double crest, and the rainfall, which is conspicuously heavy, rises gradually to a maximum in June, then falls off, only

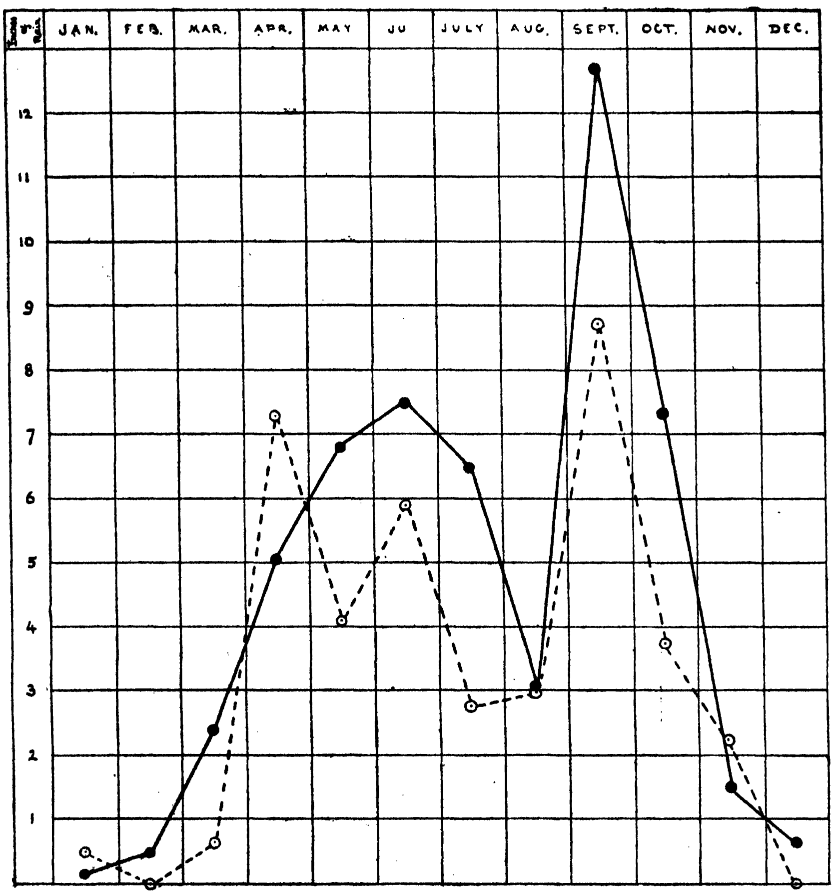


Fig. 1.—Curves showing the rainfall in Ilorin Province; the black line represents the average rainfall for the seven years, 1905 to 1911; the dotted line shows the rainfall for 1912.

to bound up again to its highest point in September. The rainfall is peculiar also inasmuch as normally no month is absolutely rainless, although but little is recorded during December, January and February. The curve reproduced above shows in a graphic manner the average rainfall for the last seven years (1905–1911). The rainfall for the present year (1912) is also shown, as it has been exceptional, a drought occurring from May to August, and it may therefore have had a bearing on the distribution of the tsetse-flies.

Methods of Collecting.

My duties necessitated my presence at Ilorin during the greater part of my tour of service, and it was impossible for me to visit every part of the province personally. I therefore engaged a number of natives, and having trained them to recognise and catch tsetse-flies, sent them out into the different districts as collectors. Of the large number of natives who passed through my hands most were found to be of little use, because, although they were able to catch specimens where they were plentiful, they lacked the perseverance, or some peculiar personal

Fig 2.—Umoru, a Fulani of Yola, one of my native collectors.

allurement, necessary to procure them in less likely spots. Eventually, however, I was able to select three or four who showed some aptitude and a degree of discrimination, and by them were made most of the collections on which this report is based. I was also fortunate enough to obtain the co-operation of the Administrative Officers, who interested themselves in the work and not only furnished me with valuable information but also consented to take collectors with them when

on tour in their divisions, thus enabling me to obtain insects even from the most remote corners of the province.

The specimens include representatives from practically every district, excluding only the great uninhabited tracts. Altogether 612 collections were obtained from more than 500 different localities, and so far as is possible these are indicated on the accompanying map by means of the conventional signs suggested by Dr. J. J. Simpson.* As, however, the incompleteness of the geographical survey renders it impossible to mark down all the places accurately, an alphabetical list of them is appended. The list has, of course, a positive value only; and no doubt in many places the flies were overlooked, either because they were present in small numbers, or because the conditions were unfavourable—the day may have been wet or cloudy, or the locality may have been visited in the early morning before the flies were abroad. My own rule, and the instructions I gave to my collectors, was to stop at every stream or closely wooded spot for half an hour. If in this time no tsetse-flies were seen, it was concluded either that they were not present, or that they were present in such small numbers that, for all practical purposes, they were not a menace to cattle or transport animals.

The species of *Glossina* noted were *G. palpalis*, *G. tachinoides*, *G. submorsitans*, and *G. longipalpis*. Speaking generally, it may be said that *G. palpalis* and *G. tachinoides* occurred in all districts of the province. *G. submorsitans*, however, was restricted to the eastern division in a somewhat curious manner.† No flies of this species were taken to the west of a line corresponding roughly with the fifth degree of longitude, and none were found further south than Egbe and Ofa Ora.

The Main Rivers.

Several collections have been obtained from different parts of each of the six main rivers which traverse the province. The actual courses of these streams are largely conjectural; but as, in the case of each river, collections are included which were obtained at widely separated points extending from the vicinity of its source to the neighbourhood of its confluence with the Niger, I do not think that it is an unreasonable assumption to suppose that the intermediate reaches are similarly tsetse-haunted. To substantiate this belief, a short stretch of the Oyun River was examined in greater detail, namely, the six or seven miles which run between the point where the river is crossed by the main road from Ilorin to Balogun and the railway bridge close to the confluence of the Oyun River with the Aza (Pl. I., fig. 2). The accompanying sketch-map shows the tsetse-flies taken at the fourteen points at which the river was examined.

On each of the six rivers *G. palpalis* and *G. tachinoides* occurred, and, in addition, *G. submorsitans* was found to frequent the River Kampe, as well as the northern portions of the Oro and the Oyi.

* Bull. Ent. Research, ii, Jan. 1912, p. 297.

† In this paper Zumbufu has been included in the eastern division in consideration of its geographical position, although for administrative purposes it is assigned to the western division.

The Western Division.

In the western division of the province the country is thickly populated and well cultivated, and, in consequence, many of the streams are but lightly shaded by trees. Tsetse-flies are correspondingly scarce, and I have often spent an

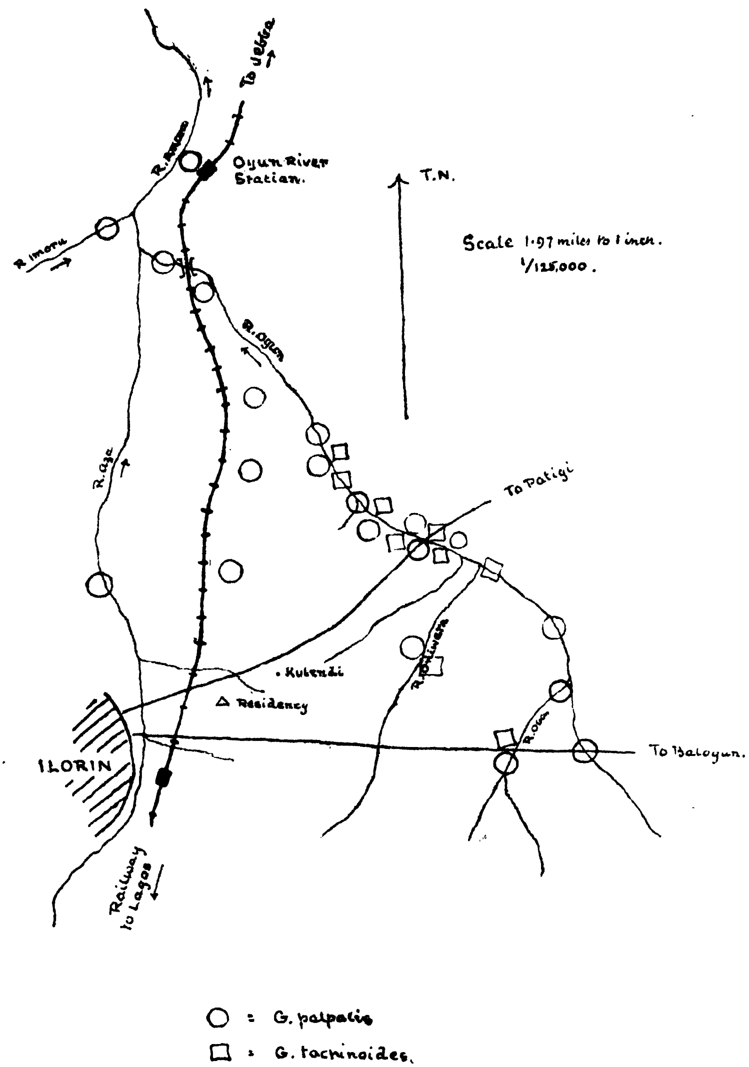


Fig. 3.—Sketch-map of the Oyun River showing the points at which tsetse-flies were taken between the Balogun road and Oyun River railway-station.

hour or more waiting at a likely spot before taking a single specimen. I have, however, never failed to find the flies eventually where there was deep shade and either a stream or pools of water, except in the cases of one or two isolated patches of bush.* In the immediate vicinity of Ilorin town I was able myself to

* *See* p. 13.

investigate the distribution of the tsetse-flies in greater detail, and the results obtained in this district might, I think, be considered to apply to the whole of the great central plain of Ilorin.

G. palpalis and *G. tachinoides* were the only species noted in this division. It was seldom that a distinction could be detected in the haunts of these insects, both being widely distributed over the country, and both, as a rule, occurring beside the streams wherever the conditions were favourable. In some places, however, there was a difference, as, for instance, on the Weru River where it is crossed by the road from Paiye to Ilorin (Pl. II, fig. 1). Here, after taking several specimens of *G. palpalis* in the river-bed, I returned to my horse, tethered, as I hoped, out of harm's way in an open space some distance from the river, only to find him tormented by a dozen *G. tachinoides* which were biting at his fetlocks.

Nowhere in this division were the tsetse-flies sufficiently numerous to be a scourge ; and this fact alone, whether it be due to the denser population and the greater proportion of agricultural land or to some difference in the vegetation, constitutes a remarkable contrast to the conditions obtaining in the eastern and southern divisions. It is, moreover, noteworthy that in crossing the uninhabited district to the north-west of the River Weru, I did not discover tsetse-flies until the River Iwa was reached, although the vegetation was of the type that is generally frequented by *G. submorsitans*, and the district was reputed to be well stocked with game (Pl. II, fig. 2).

In spite of the general occurrence of tsetse-flies, numerous herds of Fulani cattle are seen throughout the greater part of the western division, and appear to thrive there. Moreover, it would be a matter of no great difficulty to render the roads almost everywhere comparatively free from tsetse-flies, owing to the relatively small numbers of these insects and the strict localisation of their haunts. This step is an essential preliminary to the opening-up of the country and the introduction of animal transport, as the following incident proves. In June 1912, I undertook, at the request of the Resident, to locate the tsetse-flies on the road from Ilorin to Agugi, along which it was proposed to try an experiment with donkey transport. The road, which runs almost due east from Ilorin, is about thirty miles in length, and traverses country which is overgrown by grass, and dotted with scattered trees. Where there is a sufficient depth of soil above the rocks, and in the river valleys, numerous farms occur, planted mainly with yams, maize, and ground-nuts ; and at several places, as, for instance, around Iliapa, Balogun, and Agugi, herds of cattle graze. Only at a few points does the road pass through patches of orchard land, and, except on the river-banks, there is between Ilorin and Lalenka no cover sufficiently deep to form a haunt for tsetse-flies. The road crosses three rivers—the Oyun, the Oshin, and the Oyi—and a number of lesser streams, tributaries of these. The banks of all the streams are narrowly fringed with trees and undergrowth which in most cases harbour tsetses, although the depth of the fringe is never more than a few yards. Tsetses were taken on the banks of each of the three main rivers near the points where the road crosses them ; they were also taken on one or more of the tributaries of each. The species was in every case *G. palpalis* ; but at one river—the Oyun—*G. tachinoides* was found in addition (Pl. I, fig. 2). Under these circumstances

it seemed reasonable to assume that the presence of tsetse-flies on any of the streams on the Agugi road is determined by the suitability of the conditions, the most important of which appears to be the presence of deep shade ; and I came to the conclusion that, provided the crossings were properly cleared, the road might safely be used for animal transport. Unfortunately, it was necessary to send out the first drove before the clearing could be effected, and ten healthy donkeys left Ilorin for Agugi on 4th August. On 14th September only three survived, all suffering from trypanosomiasis ; and the last of these died on 1st November, within three months of the beginning of the experiment.

The Eastern Division.

In the eastern division of Ilorin province there are two great uninhabited districts lying on either side of the Kampe River, and a third smaller uninhabited tract just south of Zumbufu. Although it was not possible to examine this division with the same thoroughness as the western, yet the 188 collections obtained are representative of all the inhabited regions, and are probably typical of the whole division.

The tsetse-flies collected were of the following species : *G. palpalis*, *G. tachinoides*, *G. submorsitans*, and *G. longipalpis*. On referring to the map it will be seen that the first three species are distributed over practically the whole district, the only important exception being the country lying to the west of Oke Odde, where only *G. palpalis* and *G. tachinoides* were found. *G. longipalpis* was taken in only a few localities, and as they are widely separated, it is possible that this species has been overlooked in the intervening areas.

The vegetation of this division is generally closer than in the western division, the country is less widely farmed, and in places there are actual belts of forest. This, no doubt, accounts in part for the general distribution of *G. submorsitans*, a species which is absent from the western division. Many of the collections which contained specimens of *G. submorsitans* were, however, made actually on the banks of streams, and there seems to be no doubt that, during the dry season at any rate, this species of tsetse is to be found in considerable numbers along the rivers. On the banks of the Noako River, for example, *G. submorsitans* was abundant during the dry season ; but later in the year, in October, towards the end of the rains, they were conspicuously less numerous. At several places where tsetses of the *palpalis* group only were found during the dry season, *G. submorsitans* was present in addition during the rainy season, a fact that considered in conjunction with the preceding observation, suggests that this species takes refuge in the dry season near the rivers. It would, therefore, be interesting to ascertain whether, by clearing the banks of this stream so as to deprive them of this refuge, the subsequent dissemination of *G. submorsitans* in the neighbouring country might not be checked, as it was found to be in the case of *G. palpalis*, by the clearing of the belt at Offa.* In the dry season, moreover, the vicinity of the Noako River is the haunt of big game. As might be expected from the nature of the country, tsetse-flies are much more common

* *See* pp. 12–13.

in the eastern than in the western division ; in some places, as, for instance, on the River Noako, they are a serious inconvenience.

Along the northern border of this division, from Patigi to Lafiagi and on to Zumbufu, runs the main caravan highway through the province, and during the dry season a constant succession of droves of cattle passes along this road on the way to the Coast. The herdsmen of the north have not yet adopted the facilities offered by the railway for transport, and still frankly prefer the slow but familiar method of driving their beasts hundreds of miles by road. Many of the herds come from Kano and even more distant regions, and the toll that they pay by the wayside must be immense. As they pass through Ilorin province they must trek, between Patigi and Zumbufu, through country infested with *G. submorsitans*, in which the local herdsmen have found it impossible to rear cattle ; * that many of their beasts sicken in consequence and have to be slaughtered is only too certain. In Ilorin town, for instance, which is reached some days after leaving the eastern division, large numbers of sick animals are butchered, and, on making an examination of their blood, I found that the majority were suffering from trypanosomiasis. In most cases the species of trypanosome was *T. vivax*. It is probable, therefore, that the animals had been infected prior to their entry into Ilorin province, for, according to Sir David Bruce and his collaborators on the Sleeping Sickness Commission in Uganda,† the average incubation-period of *T. vivax* in cattle is eighteen days, and the average duration of the disease 89 days. As the cattle slaughtered in Ilorin were often in an advanced stage of trypanosomiasis, these figures would necessitate dating back the infection to a time long before they crossed the Niger. The Nigerian strain may not, however, be identical with that of Uganda, and may possibly have a shorter period of incubation. In horses, at any rate, the onset appears to be rapid, for I have seen a pony in an advanced stage of the disease 14 days after the earliest possible date of infection, and another which showed undoubted symptoms only four days after entering tsetse country.

Unlike the western division, which is well stocked with cattle, the eastern division possesses no Fulani herds, excepting in the extreme westerly portion of the Oke Odde district, in an area near the River Oyi, bounded to the east by a line running from Famali to Oke Odde, and southwards as far as Ora. In the Annual Medical Report on Northern Nigeria for the year ending 31st December 1910, Dr. M. Cameron Blair, Senior Sanitary Officer, wrote : "In Northern Nigeria we fortunately possess, apart altogether from scientific observation, a very good rough-and-ready means of determining the distribution of tsetse-flies at any given part of the year. The Fulani, over the greater part of the Protectorate . . . . possess most of the cattle in the country . . . . For centuries these people have been in the habit of wandering all over the country in pursuit of pasture for their cattle and other live-stock. Apart altogether from the question of the absolute presence or absence of water, these people avoid certain parts of the country at certain seasons, and shun other

* An enterprising herdsman recently attempted to settle near Lafiagi. In September, shortly before I left Ilorin, I heard that his cattle were dying off, thus once more proving the unsuitability of this district for Fulani herds.

† Reports of the Sleeping Sickness Commission of the Royal Society, no. xi.

regions at all times. Now many of those areas, thus permanently or intermittently avoided, appear, to the cursory observer, ideal cattle countries; but their long experience has taught those people that, if they do not act as described, their cattle will die. They believe that in the regions avoided the water is either permanently or intermittently poisonous. . . . Investigation invariably shows that the water itself is not poisonous, but is haunted by tsetse-flies." The eastern division of Ilorin province is one of the areas shunned *at all times*, although the country appears to afford excellent grazing grounds; and this is doubtless due, as Dr. Blair points out, to the presence of tsetses. But I have already stated that tsetses haunt practically every stream in the western division, and that nevertheless cattle are abundant. There is, however, one great difference between the two districts: whereas *G. submorsitans* occurs all over the eastern division, it is apparently completely absent from the western; and this being so, I think the assumption is reasonable that it is this species that is inimical to live-stock. If further proof be necessary, it is furnished by the fact that the one district in the eastern division in which cattle are kept is the only one in which *G. submorsitans* has not been found.

The Southern Division.

The southern or Offa division of the province has been less thoroughly surveyed for tsetse-flies than either of the other two, and the tour on which most of the entries on the map are based was made in September, a very wet month, when circumstances were unfavourable for collecting. Nevertheless the 79 collections were obtained from localities fairly evenly distributed over the whole division, and are probably representative. The only tsetses taken were *G. palpalis* and *G. tachinoides*. *G. palpalis* appears to be distributed over the whole division, and *G. tachinoides*, although caught at only a few places, may be more widely distributed, at any rate in the western districts, than is indicated on the map. The vegetation in this division, however, is less open than in the western division, and resembles the typical habitat of *G. palpalis* more closely than that of *G. tachinoides*. It has been pointed out by Roubaud* that, in West Africa, *G. palpalis* is gradually replaced by *G. tachinoides* as an advance is made inland beyond the forest belts. In this respect the province of Ilorin would seem to cover the intermediate zone, *G. palpalis* predominating in the southern division, but occurring in approximately equal proportions with *G. tachinoides* a little further north, in the western and eastern divisions.

The most remarkable feature of the survey is the apparent absence of *G. submorsitans*, a species which occurs in large numbers in the southern part of the eastern division. It is possible, of course, that the fly may have been overlooked; but it is improbable that no single specimen should have been taken if the species is at all common. From the fact that Fulani cattle are not taken to graze in the southern and eastern parts of the division it was anticipated that *G. submorsitans* would have been found; and, if it is really absent, some other explanation than the presence of this fly must be given to account for the fact that the greater part of the region is shunned by herdsmen.

---

* Comptes Rendus de l'Académie des Sciences, 2nd Oct. 1911.

In many parts there is thick bush, and the tsetse-flies are very numerous, either of which circumstances might deter the Fulani from leading their herds here to graze; moreover, the more easterly districts would be reached most naturally from the north, when a wide stretch of country infested by *G. submorsitans* would have to be crossed. There is no doubt, however, about the fact that infection with *T. brucei* can be incurred in this division, and the experience of successive Residents has been that the ponies they use on tour in the eastern districts almost invariably die. Game is fairly plentiful in certain parts of the division, as it is in the eastern or Patigi division, whereas it is scarce in the western division; and it is possible, therefore, that trypanosomiasis may be maintained, in this instance, by infected game, and transmitted from them to any horses or cattle that venture into the neighbourhood.

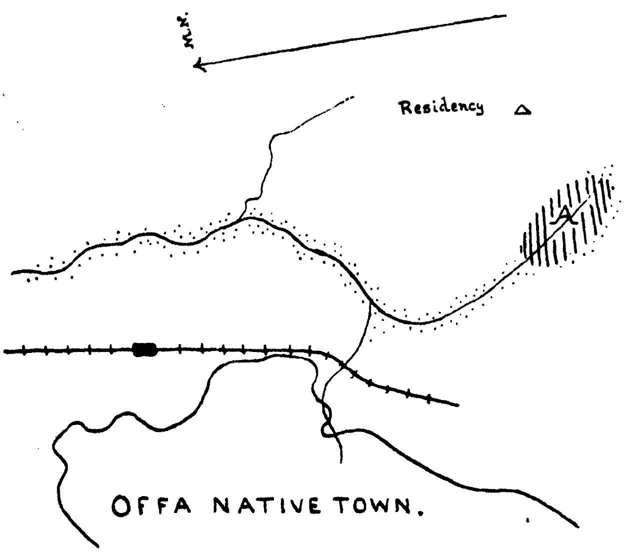


Fig. 4.—Plan of Offa, (A) being the tsetse-haunt.

At Offa itself, which is not only a large native town, but also an important station of the railway, only *G. palpalis* was found. On the western side of the line lies the native town, and on the eastern the residential quarters for Europeans; on the latter side the ground rises gently and at the foot of the slope a small stream runs northwards in a direction parallel to the railway. The sloping ground is divided in two places by narrow valleys, on the ridge between which the Residency stands, and but a little way to the south lies an isolated patch of marshy ground from which originates a small stream. When I visited Offa, in April 1912, this patch of marshy ground (marked A on the plan) was covered with trees and undergrowth, and was found to be the haunt of abundant tsetse-flies (Pl. III, fig. 1).

The rest of the station was sparsely wooded and apparently free from these insects; but as I was assured that during the rains they were sometimes seen even in the bungalows, I concluded that during the dry season the swamp formed

a retreat for the flies, whence they spread over the surrounding country during the rains. I therefore recommended that all the undergrowth should be cleared away, and that the marsh itself should be drained by digging a ditch through the middle. This was done, apparently with good results, for although the haunt was thoroughly searched in July, August and September—that is during the height of the rains—no tsetse-flies could be found; and the European residents informed me that they had not observed any in their offices or bungalows.

As already stated there are in the western division some isolated patches of bush, skirting the smaller streams or surrounding pools, in which I was unable to find tsetse-flies although the local conditions appeared to be suitable. This fact suggests that, in the event of a patch of bush becoming isolated by cultivation or otherwise, it remains for some time a tsetse-haunt, and as in the case of the swamp at Offa, serves as a retreat for the flies in the dry season; but that eventually its tsetses die out, a process that may be accelerated by clearing away all undergrowth.

The Small Race of G. palpalis found in Ilorin.

By far the most common tsetse-fly in Ilorin is one which differs markedly in external characters from any of the recognised species, but which has been identified as *G. palpalis* by both Professor Newstead and Mr. Austen. It is a small fly, with abdominal markings practically identical with those of *G. tachinoides*, with the one exception that the buff colour of the paler areas is replaced by a very characteristic grey-blue tint. Specimens were sent to the Entomological Research Committee, and were very kindly examined by Mr. Marshall, who wrote saying that he could not regard them as being specifically distinct from *G. palpalis* because the genitalia of the males* were practically inseparable. In another letter he wrote that they constituted the principal difficulty in dealing with my collections, for he had found discoloured specimens of *G. tachinoides* extremely hard to distinguish from this very small race of *G. palpalis*.

* In a fresh preparation the details of the genitalia of the male differ considerably from those seen after treatment with caustic potash. Maceration, as might be expected, destroys all the finer structures, and distorts the natural arrangements of the organs. This is conspicuous in the case of the inferior clasper. In a macerated specimen the terminal portion of the inferior clasper is extended into a leg-like process, ending in a foot-like extremity which overlaps its fellow of the opposite side in the middle line. In a fresh specimen, on the contrary, the leg-like process of the inferior clasper is seen to be bent upwards into an S-shaped structure. The first bend occurs at the proximal end of the process in an upward and outward direction, the second in the middle of the foot-like extremity in such a way as to curve the toe upwards and backwards over that part of the extension which, to preserve the analogy, must be called the ankle. Looking at the hypopygium from above, therefore, in a specimen from which the point of the superior clasper has been broken off on one side, a clear outline of the broad basal portion only of the inferior clasper can be seen at the lowest focus. On raising the focus a little the ankle of the leg-like process comes into view, with the sole of the heel and the folded border of the toe forming a line parallel to, but behind, the lower incurving border of the broad basal part of the clasper. At the highest focus only the toe is seen clearly, its tip pointing directly backwards. In a side view the extension of the inferior clasper resembles a snake poised with its head drawn back ready to strike.

The plate (Pl. VII) indicates how unlike these tsetse-flies are to the typical *G. palpalis*, but in view of the structure of the male genitalia, it is, I suppose, only possible to relegate them to that species.

Tsetse-flies of this type were collected from every part of the province and were often found associated with typical *G. palpalis* and *G. tachinoides*. At only a few places were typical *G. palpalis* found alone. A larva deposited by one of these flies measured 4 mm., by 1.5 mm., by 1.5 mm.

Mites found on Tsetse-Flies.

On a few specimens of both *G. palpalis* and *G. tachinoides*, taken during the months of May, June, and August, minute red mites were found attached to the abdomen, thorax, or legs. They were easily detached by the point of a brush, and in one instance the mite voluntarily left the tsetse-fly and was found crawling over the floor of a store-box. They were of two distinct types, and although at the same seasons other mites were common on such insects as mosquitos, *Chrysops*, *Stomoxys*, etc., the forms found on the tsetse-flies were not observed on any other insects. Specimens of these mites were submitted to Mr. S. Hirst, of the British Museum, who very kindly examined them, and expressed the opinion that they were larval forms of TROMBIDIIDAE, and probably belonged to the genus *Trombidium* in its wide sense.

Fulani Cattle.

The *jangali*, or cattle-tax, levied at the rate of 1*s*. 6*d*. per head on all the Fulani cattle in the province, furnishes interesting statistics as to the distribution of the herds. The table given below shows in the first column the sum collected in each district for the year 1911, in the second the approximate area of the districts, and in the third the number of head of cattle per square mile. The figures, which are, of course, only approximate, indicate with accuracy the districts in which the experience of generations has taught the natives they may safely graze their herds.

*Distribution of Fulani Cattle in Ilorin Province.**

District.	Amount of jangali in pounds (1911).	Approximate area in square miles.	Head of cattle (to the nearest whole number) per square mile.
	WESTERN DIVISION.		
Adio	63	40	21
Agodi	34	120	4
Ajidungari	102	100	14
Akambe	59	180	4
Ariore	78	110	9
Awodi	58	100	8
Igporin	193	150	18
Ilorin Town	35	100	5

* The *jangali* tax is levied on all Fulani cattle at the rate of 1*s*. 6*d*. a head. No tax is collected on the dwarf cattle found in Egbe, Eri, Ofa Ora, Oro, Osi, Idofin and Awtun.

District.	Amount of jangali in pounds (1911).	Approximate area in square miles.	Head of cattle (to the nearest whole number) per square mile.
	WESTERN DIVISION—*continued.*		
Kulendi	34	18	25
Lanwa	214	220	13
Malete	85	180	6
Okemi	36	40	12
Oke Moro	229	600	5
Oke Oyi	74	120	8
Oloru	75	80	12
Shao	24	30	11
Shari	50	330	2
Shonga—no *jangali.*			
	SOUTHERN DIVISION.		
Afon	193	150	18
Ajassepo	196	300	9
Igbaja	240	240	13
Isanlu	76	180	6
Awtun, Offa, Omu, Oke Awra, and Osi—no *jangali.*			
	EASTERN DIVISION.		
Oke Odde	40	800	1
Egbe, Ejiba, Eri, Lade, Lafiagi, Ndacheko, Ndeji, Pada, and Patigi—no *jangali.*			

A closer examination into the distribution of the cattle leads to a still further restriction of the area in which they occur. In Shari district, for instance, they are confined to Babanloma, and the neighbouring town of Ajikaji; and in Lanwa district there are no cattle north of Bode Sadu, although they are plentifully scattered throughout the southern portion of the district. Similarly, in the Patigi division the presence of Fulani cattle is limited to the extreme westerly portion of Oke Odde district, to an area bounded on the west by the River Oyi, and on the east by a line drawn from Famali to Oke Odde, and thence to Ora. There are no cattle south of Ora. In Afon, too, the majority of the cattle are found north of Ojuko, and the three or four Fulani encampments in Oke Awra district are all on the Ajassepo boundary. A glance at the accompanying map, on which the districts where Fulani cattle occur are shaded, will show that the cattle are restricted to the western half of the province, no *jangali* being collected in the eastern or Patigi division, and none in the districts along the southern and south-eastern borders. The province of Ilorin may therefore be considered to be divided roughly into two portions by the fifth degree of longitude. Experience has taught the herdsmen that to the west of this line they may safely lead their cattle to graze, but that to the east only disease and death await them.

On comparing the map which represents the distribution of Fulani cattle with the other map showing the distribution of tsetse-flies, it will be observed that the districts in which cattle are absent are, with the exception of those in the south-western corner, almost co-extensive with the districts in which *G. submorsitans* has been found. The correspondence is so close that it suggests that the presence

of this insect is the reason why cattle cannot live in these districts. As a rule the native herdsman is either unable to give any reason at all for the death of his cattle, or attributes it generally to "bad water"; the one exception of which I have heard in Ilorin was in the case of a Fulani at Lafiagi, who told Mr. Budgen, the Resident in charge of the Patigi division, that there was a fly which killed cattle in that district. On being shown a collection of tsetse-flies he singled out one, which Mr. Budgen believes to have been a specimen of *G. submorsitans*, as the sort to which he referred. That Fulani cattle live and breed, apparently in perfect health, in districts in which *G. palpalis* and *G. tachinoides* are widely distributed, is undoubtedly true; indeed it is an everyday occurrence to see herds of cattle grazing beside the streams at the very spots where these tsetses have been found to be most numerous.

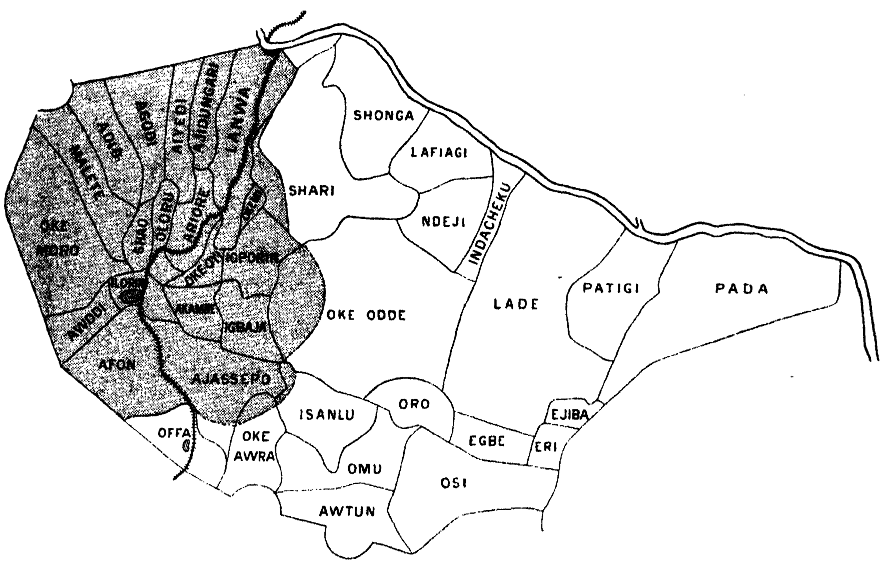


Fig. 5.—Sketch-map showing the distribution of the herds of Fulani cattle in Ilorin province.

Elsewhere* I have pointed out that in Northern Nigeria the trypanosomiasis due to *T. brucei* is much more fatal to horses than that due to *T. vivax*. If the same statement applies to cattle, this fact may partly explain the restricted distribution of the herds in Ilorin province, for *T. brucei* seems to be more common in the east and south-east than it is in the west. In Uganda, moreover, Sir David Bruce and his collaborators† concluded that the carrier of *T. vivax* was probably *G. palpalis*, and it is well known that *G. morsitans* can transmit *T. brucei*.

Dwarf Cattle.

In addition to the Fulani cattle, a few dwarf cattle are met with in the southern and south-eastern districts. A herd of these curious animals is seen amid natural

* Annals of Tropical Medicine and Parasitology, vii., no. 1, 1913.

† Reports of the Sleeping Sickness Commission of the Royal Society, no. xi.

surroundings at Eri in Plate IV. They are found in the neighbourhood of villages and towns in districts in which Fulani cattle cannot exist, and they have therefore been credited with a natural immunity to trypanosomiasis.* At Ilorin, however, I was able to prove that, in one case at any rate, infection with *T. brucei* terminated fatally, although in two cases recovery from infection with *T. vivax* was observed to occur.† It is not likely therefore that these cattle would be of any use as transport animals even if they were to prove physically capable of the work. There is some reason to suppose that these cattle, even when living in country haunted by *G. submorsitans*, may escape the attacks of these insects, as collections of biting flies made at the spots where they were actually grazing did not include this species, although specimens of both *G. palpalis* and *G. tachinoides* were taken.‡

Trypanosomiasis.

It is a fortunate circumstance that sleeping sickness does not appear to occur in an epidemic form in Northern Nigeria, in spite of the fact that tsetse-flies are very generally distributed over the Protectorate. Sporadic cases have been reported from a number of localities, and certain districts, as, for example, the province of Kabba, appear to be endemic centres of the disease. In Ilorin province, human trypanosomiasis is either very rare or altogether absent. The missionaries both at Shonga and Patigi, however, have reported cases of a fatal disease characterised by enlargement of the cervical glands and lethargy which may have been sleeping sickness. The presence of the trypanosome has not been demonstrated, and until this has been done it would be rash to make a definite diagnosis. Elsewhere in the province the disease is unknown, and no cases of even a suspicious nature came under my notice during the nine and a half months I was in Ilorin. This may be due to the fact that the native population is relatively immune to the disease, or to the absence of the species of trypanosome (*T. gambiense* and *T. rhodesiense*) which are pathogenic to man. The comparative scarcity of game, which has been proved by Kinghorn and Yorke to be the reservoir of the sleeping sickness parasite in Rhodesia, should also be remembered in considering this subject. There is indeed some reason to believe that the native population is less susceptible to trypanosomiasis in West Africa than it is in other parts of the continent. Such an opinion has been expressed with regard to sleeping sickness on the Gold Coast, and the few cases of the disease that I have met with in Northern Nigeria have been isolated instances occurring in districts in which the whole population was exposed to the attacks of innumerable tsetse-flies. In the opening up of the country it is, however, of the greatest importance to guard against the possible spread of sleeping sickness; for every development is accompanied by the introduction of individuals, both Europeans and natives, who are certainly not immune. As has already been pointed out, Ilorin occupies a somewhat precarious position from its proximity to Kabba. It

* "A third report on experimental work on Animal Trypanosomiasis," by H. Andrew Foy, D.P.H., in the Journal of Tropical Medicine & Hygiene, 16th Oct. 1911.

† Annals of Tropical Medicine and Parasitology, 1913, vii., no. 1.

‡ *Ibid.*

is moreover impossible to assert that the trypanosomes pathogenic to man do not occur in the province. A polymorphic trypanosome which is morphologically indistinguishable from *T. gambiense* is unfortunately very common in domestic animals, and in a few cases parasites with posterior nuclei have been found which resemble *T. rhodesiense*. But even if these parasites should prove to be *T. brucei*, the danger of man becoming infected from domestic animals is not altogether eliminated, for it has been suggested by Sir David Bruce that *T. brucei* and *T. rhodesiense* are one and the same trypanosome.*

But apart altogether from the danger of sleeping sickness, the question of the abatement of trypanosomiasis of domestic animals merits consideration. This disease is exceedingly common. Trypanosomes presenting the morphological characters of *T. brucei*,† *T. vivax*, *T. nanum* or *pecorum*, and *T. theileri* have been found in Ilorin in the blood of domestic animals; *T. brucei* in the horse, donkey, Fulani cattle, dwarf cattle, and sheep; *T. vivax* in the horse, donkey, Fulani cattle, dwarf cattle, sheep, goat, and dog; *T. nanum* or *pecorum* in the horse, Fulani cattle, and sheep; and *T. theileri* in the dwarf cattle.‡ As the insects that transmit the diseases to man and animals are the same, any measures adopted with a view to diminishing the spread of the latter will apply also to the former. The province of Ilorin, and indeed a large part of the rest of Northern Nigeria, suffers heavily from losses due to trypanosomiasis of horses, cattle, and other domestic animals; and the wealth of the country is curtailed to an even greater extent by the restriction of the districts in which stock can be reared. But for tsetse-borne diseases, cattle might be raised over a very much wider area of the province than is at present the case, and the numbers of sheep and other domestic animals might be greatly increased. It would moreover be possible to introduce some form of transport by means of animals, thus opening up the country more effectually, and liberating a large number of native hands for agricultural employments. In a foregoing section of this paper I have remarked that the eastern division of Ilorin province is one of the regions shunned by Fulani herdsmen, and I have suggested that of the tsetse-flies occurring in this part of the province it is *G. submorsitans* that is particularly inimical to cattle. It may be assumed at once that it is impossible to clear

* There can be no doubt that under certain conditions trypanosomes of the types generally found in animals may infect man. This fact is illustrated by the case recently published by Martin and Darrè ("Un cas de trypanosomiase humaine contractée au laboratoire." Par Louis Martin et Henri Darrè. Bulletin de la Société de Pathologie Exotique, Tome V., No. 10, 1912) in which the trypanosome was reported to have the following reactions: "Pour le virus laboratoire, très pathogène pour la souris, et manifestement du type nagana-surra, les réactions d'immunité passive croisée (pouvoir protecteur du sérum d'animaux, cobayes, chèvres, infectés) l'éloignent des *Tr. brucei* et *togolense* et le rapprochent du *Tr. evansi*."

† Considerable confusion seems to have arisen as to the type of trypanosome to which the name *T. brucei* properly applies. It should be pointed out therefore that in this paper the name *T. brucei* has been used when referring to a polymorphic parasite similar to that described and figured by Sir David Bruce and his collaborators in the Reports of the Sleeping Sickness Commission of the Royal Society, no. ~~xi~~. This trypanosome is probably that for which Prof. Stephens and Dr. Blacklock have recently proposed the name *T. ugandae*.

‡ See "Trypanosomiasis of Domestic Animals in Northern Nigeria," Annals of Tropical Medicine and Parasitology, vii, no. 1, 1913.

the whole of this country and to exterminate the tsetse-flies. What would be a very difficult and costly undertaking in a district harbouring only *G. palpalis* is an impossible one where *G. submorsitans* is concerned; and the clearing, even if once carried out, would have to be maintained year after year, or close undergrowth, the type of vegetation that is most favourable to these insects, would soon spring up. What then could be done? From the study of the tsetses in the western division of Ilorin it is evident that it is quite feasible to raise stock in districts in which these flies (*G. palpalis* and *G. tachinoides*) are widely distributed, provided that the insects are not too numerous, and are localised in definite haunts. No doubt under more favourable conditions many more herds of cattle could be maintained in this area, but the fact remains that the Fulani herdsmen already regard the country as affording good grazing-grounds, in spite of the fact that practically every stream is a tsetse-haunt. It is not therefore necessary to despair of finding grazing-grounds in some parts of the eastern and southern divisions. The country appears to be admirably adapted to such uses in many places, if only some means could be devised to protect the cattle from the attacks of tsetse-flies. The observations on the dwarf cattle recorded above suggest that this might be accomplished, and the well known fact that tsetses cannot survive exposure to direct sunshine for more than a few minutes indicates the nature of the measures that might be adopted. It would be necessary to maintain a wide area cleared of all undergrowth round the villages and towns, and to direct a number of similarly cleared roads and tracks from this centre towards the farm lands and grazing-grounds. The banks of the streams would also require to be cleared for some distance on either side of the local water supply, and at the points to which the cattle were led to drink. It might in some cases be possible to institute village grazing-grounds, suitably enclosed, and with access to a cleared reach of a stream, in which the smaller domestic animals might be confined. It would of course be necessary to change the site of these plots from time to time, but the land thus fertilised would be valuable for agricultural purposes, and by this means additions would be made automatically to the cleared areas around the villages.

Throughout the province the main roads should be cleared, and the banks of the stream for some distance on either side of the crossings. The natives should be encouraged to farm the road-sides, as cultivation has proved to be the most effective way of exterminating tsetse-flies. Not only would this protect the local cattle when moving from pasture to pasture, but it would tend to diminish the spread of infections introduced by herds passing through the province on their way to the coast. These herds trekking down from the north are a serious source of infection. For the most part they enter Ilorin by crossing the Niger at four points—Jebba, Ogudu, Likpata and Patigi—and the most natural course would be to examine the herds on their arrival at these places, and to prevent any animals suffering from trypanosomiasis from proceeding on their journey, either slaughtering them or detaining them in isolation camps. Such a measure would, however, entail the provision of a staff of trained microscopists, as animals often have large numbers of parasites in the blood, and are therefore highly infectious, some time before the appearance of symptoms; and the herdsmen themselves are accustomed to slaughter their stock

as soon as they show definite signs of sickness. Camps also should be instituted near every large town and European station, in which sick horses, donkeys, and any other animals that it was inadvisable to slaughter, might be isolated.

Great importance has recently been attributed to the *rôle* played by big game in the spread of trypanosomiasis. It should undoubtedly be determined what forms of trypanosome they harbour in Northern Nigeria; but before undertaking extensive measures to drive back the game from the inhabited areas some experiment on a large scale should be carried out on the lines suggested by Dr. Yorke. It is perhaps unnecessary to insist that, in view of the discoveries of Kinghorn and Yorke in Rhodesia, the destruction of big game in the vicinity of native towns and European stations should be encouraged instead of being artificially restricted.

I have to thank Mr. P. M. Dwyer and Mr. E. C. Duff, the Residents successively in charge of the province, and all the officers of the Administrative Department at Ilorin for their hearty co-operation, and especially Mr. R. Scott Chapman, Mr. T. A. G. Budgen, and Mr. C. S. Burnett, who when on tour in their respective divisions, and in addition to their arduous duties, undertook the supervision of natives trained by me to collect biting flies. Their assistance brought within my reach even the most remote parts of the province, and enabled me to obtain specimens from practically every inhabited district. I am also indebted to Mr. Budgen for very kindly taking the photographs which illustrate the tsetse-haunts in the eastern division of the province, and to Mr. O. Vetter for permission to reproduce his photograph of Eri.

With but few exceptions the identifications of all the tsetse-flies in the collections referred to in this paper have been confirmed by Mr. Guy A. K. Marshall to whom I wish to tender my most sincere thanks both for carrying out this tedious and difficult work, and for his unfailing kindness and encouragement.

Synopsis of localities in Ilorin province, Northern Nigeria, in which Tsetse-flies were taken during 1912.*

Western Division.

Abankola, Lanwa district ...	vi.	P.
Abeokuta, near Bangbuse ...	vii.	T.
Ademu, near Shari	viii.	P., T.
Adibongo	vi.	P.
Adio, Pools at	viii.	P.
Adio, Busamu River near ...	viii.	P.
Adiosun	vi.	P.
Adiosun	vii.	P.
Adukensi	vii.	T.
Afonkeke, Oke Oyi district ...	vi.	P.
Afonkeke	vii.	P., T.
Agara or Agura	ix.	P.
Agbabiaka, Yalu River near ...	ix.	P.
Agbadamu	ix.	P.
Agbaku	vii.	T.
Agbiyangi, and between Agbiyangi and Akibiori	x.	P.
Agbona	vi.	P.
Agodi, Small stream near ...	viii.	T.
Agodi, Pools in a stream-bed near	viii.	P.
Agoki	vi.	P., T.
Agorombi	vi.	P.
Aitoru. Between Aribi and Aitoru, near the latter	ix.	P.
Aitoru	ix.	P.
Ajidungari	ix.	P.
Akata	ix.	P.
Akata, Oyun River near	ix.	P.

* In this synopsis the following abbreviations are used:—P. for *Glossina palpalis*; T. for *G. tachinoides*; M. for *G. submorsitans*; L. for *G. longipalpis*. The month in which the species was observed is indicated by Roman numerals.

WESTERN DIVISION—*continued.*

Akibiori, and between Akibiori and Babasali	x.	P.
Akimano, near Adukensi	vii.	P., T.
Aladie, near the Aramu River ...	viii.	P.
Alapa or Alaqua, Stream a little to the west of	iv.	P., T.
Alapa	vi.	P.
Alapa. Stream-bed a little beyond the Imoru River on the Ilorin-Alapa Road	viii.	T.
Alapa-Ilorin Road. Stream-bed near Alapa	viii.	P., T.
Alapa. Stream-bed about 4 miles from Alapa on the road to Ilorin	viii.	P.
Alapa. Stream across the road about midway between the Weru River and Alapa	viii.	P., T.
Alapa. Near a village a mile or so from Alapa on the road to Oniri	viii.	T.
Alapa. Dry river-bed a little nearer Oniri	viii.	P., T.
Alapa. Marsh still further on towards Oniri	viii.	P.
Alaro, River near	viii.	P.
Alaro	viii.	T.
Alatiko	vii.	P.
Alega or Elega	vii.	P.
Aleri, Weru River near	vi.	P.
Aleri	vi.	P.
Aleyegun	viii.	P., T.
Alikun	vi.	P.
Aniya	ix.	P.
Anwa River, between Moma and Agodi	viii.	P.
Anwa River, between Oloru and Agodi	viii.	P., T.
Anwa River, between Shao and Oloru	viii.	P.
Anwa River, to the north of Shao	viii.	T.
Apada	viii.	P.
Apata	ix.	P.
Apola	ix.	P.
Arabadi	vii.	T.
Aramu River, in Agodi district	viii.	P.
Aribi, and half-way between Aribi and Aitoru	ix.	P.
Ariore. Near the wells	vii.	P.
Ariore	ix.	P.
Asekweri, Weru River near ...	viii.	P.
Asomo	viii.	P., T.
Asunara	vii	T.
Awodi, Awe River near	viii	P.
Awodi	viii.	P.
Awunyen	vii.	P.
Aza River, one mile south of Ilorin railway station	iv.	P., T.
Aza River, just below Sobe rock, Ilorin (Pl. III., fig. 2) ...	vii.	P.
Babadudu. In thick scrub about ¾ mile from Babadudu on the Ariore road	vii.	P.
Babadudu	ix.	P.
Babagba, Anwa River near (Pl. VI., fig. 1)	viii.	P., T.
Babagba, and between Babagba and Ololoro	x.	P.
Babasali	x.	P.
Babanloma	vii.	P., T.
Babanloma, A mile or two to the west of	vii.	P.
Bachitta, and on stream half-way between Bachitta and Pandaregi	x.	P.
Balogun, Stream a little to the north of	vi.	P.
Balogun. In the kurumi behind the town; no water	vi.	P.
Balogun, Stream to the west of, about half-way between Balogun and the Oshin River	vi.	P.
Balogun, Stream on the Agugi-Ilorin road a little to the west of	x.	P.
Balogun	x.	P.
Balogun, Stream on the Agugi-Ilorin road a little to the east of	x.	P.
Balogun, Ogbe River near ...	x.	P.
Bangbuse	vii.	P., T.
Banseriki, between Lanwa and Ilorin	iv.	P.
Barre, at the Oyi River near ...	x.	P.
Barre. Between Barre and the hill near Oroki	x.	P.
Bemigun	vii.	T.
Bina or Odobina	vi.	P.
Biribiri	ix.	P.
Bode Sadu. Oshin River at Bode Sadu railway station	vii.	P.
Bongbo or Kongo River, a few miles from Paiye on the road to Oniri	viii.	P.
Bude Egba	iv.	P., T.
Bude Egba	v.	P., T.
Budo Oya Deogun	ix.	P.
Budori	viii.	T.
Budu River	vii	P., T.

Western Division—*continued.*

Buduia River	viii.	P.
Busamu	viii.	T.
Busamu River, near Guduaga	vii.	T.
Busamu River, near Adio	viii.	P.
Dagbuana, Elejula River between Paiye and	viii.	P.
Dagbuana, Hamma River near	viii.	P.
Dogari, Imoru River between Awodi and	viii.	P.
Dogari or Dongari, Stream (Ala) near	viii.	P.
Dumagi. In a kurumi just behind the village	iii.	P.
Dumagi, Stream between Shari and	x.	P.
Dumagi	x.	P.
Efue	viii.	P.
Egwo River, between Lanwa and Ariore	vii.	P.
Elegberun, near Ajidungari	ix.	P.
Elehula, near Elega	viii.	P.
Eleja, near the Aramu River	viii.	P.
Elejula River, between Paiye and Dagbuana	viii.	P.
Elelemezi, near Aramu	viii.	P.
Elemeri	ix.	P.
Famali. Stream near Famali on the road to Shari	x.	P.
Famali, Stream half-way between Shari and	x.	P.
Fata, and on Awhong River near Fata	vi.	P.
Fata, *Ruga* at	viii.	P., T.
Fata. Elebue River, a tributary of the Awhong River, 3 miles south of Fata	viii.	P., T.
Fata. Elefura Stream, a tributary of the Weru River, 2 miles N.W. of Fata	viii.	P., T.
Fata. Onibongbo River, tributary of the Awhong River, near Fata	viii.	P., T.
Fata. Awhong River on the road between Elega and Fata	viii.	P.
Gabe, near Lanwa	vi.	P.
Gambari, near Pako	ix.	P.
Geruwu, and on stream near Geruwu	viii.	P.
Geruwu, Stream half-way between Sokoto and	viii.	P.
Gori	vii.	T.
Guduaga	vii.	T.
Gunia, Pools of a stream near	viii.	P.
Gunia, Dry bed of a stream near (to N.W.)	viii.	P.
Gwandegi	x.	P.
Hamma River, near Dagbuana	viii.	P.
Ibada	vii.	P., T.
Idianya	vi.	P., T.
Idiko	viii.	P., T.
Idiya, and on stream near	vii.	P.
Idula	vii.	T.
Igbeode	vii.	T.
Igbaja, Asseya River near	ix.	P.
Igbaja, Malete River near	ix.	P., T.
Igbaja	ix.	P.
Igbamalaba	vii.	P.
Igbo River. A stream a little on the Weru side of Oke Barbar Hills	viii.	P.
Igbokedu or Bokedu, half-way between Balla and Wara	viii.	P.
Igporin, Stream half-way between the Oshin River and	iv.	P.
Igporin	viii.	P., T.
Igrunia, near Igbeode	vii.	T.
Ilanyamyamo, near the River Imoru, on the road from Ilorin to Awunyen	vii.	P., T.
Ilayetu	vii.	T.
Iliapa. Stream on the Agugi-Ilorin road between Iliapa and the Oyun River	x.	P.
Iliapa. Stream on the Agugi-Ilorin road a little to the west of Iliapa	x.	P.
Iliapa	x.	P.
Iliapa. Stream on the Agugi-Ilorin road just to the east of Iliapa	x.	P.
Ilonwyi	vii.	P., T.
Ilorin, Oyun River near (Pl. I, fig. 2)	iii.	P., T.
Ilorin. Oyun River at the point where it is crossed by the Patigi-Ilorin road	iv.	P., T.
Ilorin. Oyun River near Ilorin on the Patigi-Ilorin road	iv.	P., T.
Ilorin, Oyun River near	viii.	P.
Ilorin. Foma River, just behind the town, in an isolated clump of trees to one side of the road	viii.	P.
Ilorin. Imoru River at the crossing on the road to Alapa	viii.	P.
Ilorin. Oyun River near Ilorin on the Agugi-Ilorin road	x.	P.
Iluma	viii.	P., T.
Imoru River, just behind Ilorin town	iv.	P., T.

Western Division—*continued.*

Imoru River, on road to Ojubede	vi.	P
Imoru River, on road from Ilorin to Idiko	viii.	P., T.
Indachi	x.	P.
Iwa River, on the road to Old Oyo	viii	P.
Jato	ix.	P.
Jebba	vii.	T.
Jebba	ix.	P.
Jebba. Near Mr. Fermin's house	ix.	P.
Jebba, Oya River near	ix.	P.
Jebba. Hill called Oke Kungun, or Oke Kessa	ix.	P.
Jebba, a couple of miles to the S.E. of (Pl. V, fig. 1)	ix.	P.
Jodomo. At the railway station	vii.	P.
Jodomo. Dry stream-bed near the railway line	vii.	P.
Jodomo	ix.	P.
Konkofu	iii.	P., T.
Kulendi district. About 1½ miles N. of the Ilorin Residency along the railway line; a little on the Oyun River side of the line	vii.	P.
Kulendi district. About 2½ miles along the railway line from the Residency towards Oyun River station	vii.	P.
Kulendi district. In the bush about midway between the railway line and the Oyun River, some 3 or 4 miles from Ilorin towards the north	vii.	P.
Laiere or Ilaiere	viii.	T.
Lanwa railway station	vi.	P.
Lanwa	vi.	P.
Lanwa	ix.	P.
Lanwa, a little to the north of	ix.	P.
Malete	viii.	P., T.
Malete, between Ologede and	viii.	P.
Malete. Apoya River, a tributary of the Busamu River, 3 miles east of Malete	viii.	P.
Malete, Busamu River east of	viii.	P., T.
Malete. Aui River, tributary of the Busamu River, near Malete	viii.	P., T.
Maluma. *Ruga* near Maluma, between Oloru and Agodi	viii.	T.
Mokolo	x.	P.
Moma, pools of a stream near	viii.	T.
Moni, near Agodi	viii.	T.
More, Oyun River just below	viii.	P.
Nafamu River, between Shao and Oloru	viii.	P.
Nafamu River, on the road to Oloru	viii.	P.
N'dafa River, between Shonga and the River Oshin	iv.	P.
Noma, near Ajidungari	ix.	P.
Nquanda	viii.	T.
Oba River, just before it flows into the Oyun River	vii.	P.
Obada	v.	P.
Obaniswa, and on River Nigia or Egia near Obaniswa	viii.	P.
Odo Agba	ix.	P.
Odo Eri, Kulendi district	ix.	P.
Odo Oba, near the Aramu River	viii.	P.
Odorogun	ix.	P.
Odumbaka	viii.	P., T.
Odumbaka, on road from Alaro to	viii.	P.
Ogatiye	x.	P.
Ogatiye, half-way between Agbiyangi and	x.	P.
Ogidi	vi.	P.
Ogundele	v.	P., T.
Ogudu	iii.	P.
Ojubede	vi.	P., T.
Oke Agba	ix.	P.
Oke Dari	ix.	P.
Oke Maifura	viii.	P.
Oke Oyi, between Oke Magura and	iv.	P.
Oke Oyi	viii.	P.
Okitepo, between Igbokedu and Wara	viii.	P.
Oloda, near Ladan	ix.	P.
Olofaganga, near Ajidungari	ix.	P.
Ologbin	viii.	P.
Ologede	viii.	P.
Ologogi	vii.	P.
Ologogi River	viii.	P.
Olororo	x.	P.
Oloru, Alako River near	viii.	P.
Oloru, Olori River two miles to the S.W. of	viii.	T
Oloru, dry stream-bed a mile or two south of	viii.	P.
Oloru. Small stream, a tributary of the Anwa, between Oloru and Agodi	viii.	T.
Omatuntu. Omogo River (pools only) near Omatuntu, on the far side of Oke Barbar	viii.	P.
Onimaji or Animaji	viii.	P., T.
Oniri. Weru River near Oniri and to the west	viii.	P.

WESTERN DIVISION—*continued.*

Oniri, banks of the Awhong River, E. of	viii.	P.
Oniri. Pools in the bed of a large stream on the Alapa-Oniri road	viii.	P., T.
Oniri. Stream-bed near Oniri on the Paiye-Oniri road	viii.	P.
Oniri. Dry bed of a stream between Paiye and Oniri	viii.	P.
Oniwara River, on the road to Budo Illa, Kulendi district ...	vi.	P., T.
Oqualaquala, under a big tree between Ibaba and	vii.	T.
Oqualaquala	vii.	P., T.
Oreri	ix.	P.
Oreri, stream to north of ...	ix.	P.
Oroki, hill between the Oyi River and	x.	P.
Oroki, and on stream near Oroki	x.	P.
Oroki, between Ogatiye and ...	x.	P.
Oshin. At the River Oshin on the Patigi-Ilorin road	iii.	P.
Oshin River, where the Patigi-Ilorin road crosses it	iv.	P.
Oshin River, where it crosses the Balogun-Ilorin road	iv.	P., T.
Oshin River, on the Agugi-Ilorin road	vi.	P.
Oshin River. Small stream, a tributary of the Oshin River, on the Agugi-Ilorin road, a little to the W. of the Oshin River	vi.	P.
Oshin River, where the Shonga-Jebba road crosses it (Pl. VI., fig. 2)	iv.	T.
Oshin River, just south of Bode Sadu	ix.	P.
Oshin River, one mile south of Bode Sadu	ix.	P.
Oshin River, three miles south of Bode Sadu	ix.	P.
Oyi River, where it crosses the Agugi-Ilorin road	iv.	P.
Oyi River, on the Agugi-Ilorin road	vi.	P.
Oyi River, about one mile north of the Agugi-Ilorin road ...	x.	P.
Oyi River, near Igbaja	ix.	P.
Oyi River. Bakin Gulbi, on main road between Shari and Zumbufu	viii.	P.
Oyi River, near Zumbufu ...	viii	P., T.
Oyun River, near Ilorin (Pl. I. fig. 2)	v., vi., vii	P., T.
Oyun River, on Patigi-Ilorin road, near Ilorin	vii.	T.
Oyun River, near Ilorin, near main caravan road	vii.	P.
Oyun River, near Ilorin. Reported by the collector to have been caught on a *chedia* tree (*Ficus sp.*)	x.	T.
Oyun River, where it crosses the Balogun-Ilorin road	iv.	P., T.
Oyun River, on the Agugi-Ilorin road	vi.	P.
Oyun River. Small stream to the W. of the Oyun River on the Agugi-Ilorin road	vi.	P., T.
Oyun River, just beyond the stream Oniwara	vii.	P.
Oyun River, half-way between the streams Oniwara and Oba ...	vii.	P.
Oyun River, a little to the N. (towards the River Anwa) of the Patigi-Ilorin road	vii.	P., T.
Oyun River. About $\frac{1}{2}$ mile further along the river in the same direction	vii.	P., T.
Oyun River. About $\frac{1}{4}$ mile further on in the same direction	vii.	P.
Oyun River. About $\frac{1}{4}$ mile further on in the same direction	vii.	T.
Oyun River. About $\frac{1}{2}$ mile further on in the same direction	vii.	P., T.
Oyun River. About $\frac{1}{4}$ mile further on in the same direction	vii.	P.
Oyun River. To the west of the railway bridge over the Oyun River close to Oyun River Station	ix.	P.
Paiye	viii.	P.
Paiye. Stream between Paiye and the Weru River on the Paiye-Malete road	viii.	P.
Paiye. Onikonko River 2 miles to the N. W. of Paiye	viii.	P.
Paiye. Stream between Paiye and Oniri	viii.	P.
Pako. Oni Pako	ix.	P.
Pako. At the new Rest-House on the road to Jebba a little way from Pako	ix.	P.
Pako, between Jebba and ...	ix.	P.
Pandaregi, stream on the road between Bachitta and	x.	P.
Pandaregi	x.	P.

Western Division—*continued.*

Pandaregi. Ndafa River on the road from Pandaregi to Shari...	x.	P.
Pasa River	viii.	P.
Patiko, and on stream between Patiko and Indachi	x.	P.
Popo, near Awodi...	viii.	P.
Sapata	x.	P.
Shao, River Anwa near	iii.	P.
Shao, River Imoru near	iii.	P.
Shari or Sharagi	vii.	P.
Shari	viii.	P.
Shari	x.	P.
Shari. Hill behind the town ...	x.	P.
Shari. Pool near Shari on the road to Dumagi...	iii.	P.
Shari. Stream half-way between Shari and Dumagi	iii.	P.
Shari. Stream between Shari and Dumagi	x.	P.
Shari. Kurumi on the road to Lafiagi	x.	P.
Shari. Stream on the Shari-Famali road, nearer Shari ...	x.	P.
Shonga. At a stream just behind the town	iii.	P.
Shonga. On the fringe of a clump of trees at the margin of the lagoon just outside the town ...	iii.	P., T.
Shonga	iv.	P., T.
Shonga, and on the river which flows from Dumagi to Shonga...	x.	P.
Sokoto	v.	P.
Sokoto, Pasa River near	viii.	P.
Sokoto. Stream beyond Sokoto towards Awodi	viii.	P.
Umaso	vii.	P., T.
Wara	viii.	P.
Waro Olope	viii.	P.
Weru River (near), to the N.W. of Agodi district	viii.	P.
Weru River (near), in the N.W. corner of Agodi district ...	viii.	P.
Weru River, on road between Gunia and Laoli; at present only pools. (Pl. II., fig. 1.) ...	viii.	P.
Weru River, where the Paiye-Malete road crosses it	viii.	P., T.
Weru River, between Oniri and Paiye	viii.	P.
Weru River. Collection made at various points along the Weru River between the crossing on the Oniri-Paiye road and the junction with the Awhong River	viii.	P.
Weru River, at the crossing on the road from Paiye to Alapa ...	viii.	P., T.
Yaru. Small stream, a tributary of the Oyi River, to the E. of Yaru	vi.	P.
Yaru, Small stream to the W. of	vi.	P.
Yaru, Oyi River beyond	vi.	P.
Yaru, Small stream between Balogun and	vi.	P.
Yaru	x.	P.
Yaru, Stream a little to the E. of	x.	P.
Yuregi, At a *ruga* near	viii.	P.

Eastern Division.

Agugi, Valley ½ mile to S.W. of	iv.	P.
Agugi, Ogu River ½ mile to S.E. of	iv.	P.
Agugi. Ogu River, a tributary of the Oyi River, near Agugi ...	iv.	P.
Agugi	vi.	P., T.
Agugi. River just behind the village	vi.	P.
Agugi. Stream to the W. on the Ilorin road	vi.	P.
Agugi. Small stream a little to the E. of the Oyi River ...	vi.	P.
Agugi	x.	P.
Ahun, on Oro River	x.	P., T.
Ajikuami, and also a little to the S. of Ajikuami	x.	P.
Arido River, between Egboro and Egbe	vii.	M.
Babanzauri	vi.	P.
Bada	x.	P.
Badokin	x.	T., M.
Bongbo, and between Bongbo and Oke Odde	x.	P.
Bongi. Kuyi River near Bongi on the Patigi-Ilorin road	iv.	P.
Busa, Kurumi by the Kussuko River near	v.	P., T., M.
Busa, Kussuko River near ...	v.	P., T.
Busa, Oyi River near	v.	P., T.
Checkela, Nyemi River near ...	x.	M.
Daji. Stream near Daji on the Rogun-Patigi road	v.	P., T.
Daji	x.	M.
Duro, near Pada	—	P., T., M.
Eche River, near Patigi	v.	P.

Eastern Division—*continued.*

Edogi Chapaka, Niger flats W. of	v.	P., T.
Edogi Chapaka, Niger flats near to (not near water)	v.	P., T., M.
Edogi Pasanako. Edge of Niger flats	v.	P., M.
Egbe	vii.	P., M.
Egbe	viii.	P.
Egbom, Niger River near ...	v.	T.
Egboro	vii.	P., M., L.
Egboro	viii.	P., M.
Egboro	x.	T., M.
Egboro, stream three miles south of	x.	M.
Egboro. Between Egboro and Egbe, two miles N. of the Noako River	x.	P., M.
Ejiba	vii.	M., L.
Emoworigi, near Lattai	x.	P., M.
Emoworigi, Between Kussoko and	x.	P., T., M.
Ere	vii.	M.
Ere. Caught where cattle were grazing	x.	P.
Eri (Pl. IV.)	vii.	T., M., L.
Eri	viii.	T., M.
Erufu	v.	P.
Erufu, between Patigi and ...	v.	P., T.
Erufu	vii.	M.
Erufu	x.	P., T., M.
Erufu, between Egboro and ...	x.	M.
Etchi	vii.	P., M.
Etchi, between Fei and	vii.	P., T., M.
Famali, at the Oye River near ...	iv.	P.
Famali	x.	P.
Fei	vii.	P., M.
Gada	v.	P., T., M.
Gada, between Erufu and ...	v.	P., T.
Gaji. Near Gaji on the Rogun-Patigi road	v.	P.
Galogi	vii.	P., M.
Galogi, and on Nyemi River near Galogi	x.	P., T., M.
Galogi, between Erufu and ...	x.	P., M.
Gbodu	viii.	T., M.
Godiwa, near Patigi	v.	P., T.
Gudu Zuru, between Lafiagi and	v.	P., T.
Idorfin, Kabba Province	vii.	P., T., M.
Isanlu (Oke Oloke), between Lata and	v.	P.
Jijikuo, between Pada and ...	v.	P., T.
Jijikuo, between Rogun and ...	x.	T., M., L.
Kasagi	vii.	M.
Katsido	x.	P., M.
Koro	vii.	P., M., L.
Kusofini, on the Oke Odde-Lafiagi road	iv.	M.
Kusogi Danshi, between Patigi and	v.	T.
Kussuko River	v.	P., T., M.
Kussuko River, between Zumbufu and Lafiagi	vii.	T.
Kuyi River, five miles south of the main Patigi-Ilorin road ...	v.	P.
Labaka, a little to the E. of ...	x.	P.
Labaka, and again a little to the W. of Labaka	x.	P.
Lade, Duku River on the main road near	iv.	P., T.
Lade, stream one mile to the W. of	v.	P., T.
Lade, three miles south of ...	v.	P., T.
Lade	viii.	P., T., M.
Lafiagi, swamp in Egua valley ...	iv.	P., T.
Lafiagi	v.	P.
Lafiagi, Egua River near... ...	v.	P., T.
Lafiagi, stream between the Kussuko River and	v.	T.
Lafiagi, ten miles to the west of	v.	P., T.
Lafiagi, Niger flats five miles to the N.W. of	v.	P.
Lafiagi	vi.	P.
Lafiagi	viii.	P., T., M.
Lah, swamp opposite to	v.	P.
Lah, edge of the Niger flats opposite to	v.	P., T.
Lalagi, between Lade and ...	iv.	P., T., M.
Lalagi, between Ruganagaji and ...	iv.	P., T., L.
Lalagi	vi.	P.
Lalagi. Odo Oni Pako, the water of Lalagi, on the Lade road ...	viii.	P., T.
Lalagi	viii.	P., T., M.
Lata, between Lade and	v.	P., T.
Lata...	v.	P., T.

EASTERN DIVISION—*continued.*

Lattai	x.	T., M.
Likpata	v.	P.
Magi, Pada district	vii.	T., M.
Mamba	x.	T., M.
Matokun	viii.	P., M.
Matokun, and on Kussoko River near Matokun	viii.	M.
Matokun	x.	P., T., M.
Matokun, between Egboro and	x.	M.
Matokun, between Oke Oluchi and	x.	M.
Matokun. In a typical kurumi	x.	M.
Michian Gidda, between Zumbufu and Lafiagi	viii.	T., M.
Morrufugi, by R. Nalli, 4½ miles E. of Patigi	v.	M.
Morrufugi	x.	T., M.
Ndeje, near Lade	viii.	T., M.
Ndeliman, on Oke Odde-Lafiagi road; not on a river bank	iv.	P.
Noako River, between Egboro and Egbe	vii.	P., T., M.
Noako River. Tsetses very plentiful here in the dry season in the river bed, and particularly in the bushes which overhang the pools of the river. Buffalo graze along the banks in the dry season. Tsetses not so numerous in the wet season	x.	P., T., M.
Obala	vi.	P., M.
Odo N'la near Eri	viii.	T., M.
Odo Okeri, stream five miles from	x.	P., T.
Odo Okeri. Kurumi at the Rest House	x.	P.
Odo Okeri. Caught where cattle were grazing	x.	P.
Ofa Ora	vi.	P., T., M., L.
Ogu River, between Ora and Agbeoku	iv.	P.
Oke Odde	x.	P.
Oke Odde, stream to west of	x.	P.
Oke Odde, half-way between Labaka and	x.	P.
Oke Oloke, on the trade-route from Patigi to Awtun	v.	P., T.
Oke Oloke (Sanlu), four miles to the N.E. of	v.	P., T.
Oke Oluchi	x.	M.
Oke Oluchi, in sparse bush on top of hill at	x.	P., T., M.
Oke Oluchi, on banks of running stream near	x.	M.
Oke Onio	vi., x.	T.
Ologoma	x.	P.
Ora	vi.	P., T.
Ora	x.	P.
Ora, Awere River between Bongbo and	x.	P.
Oro	vi.	P., T., M.
Oro	x.	T.
Owa	vi.	P.
Pada, stream between Jijikuo and	v.	P.
Pada	vii.	T., M.
Patigi. Eche River near the Patigi Residency on the Patigi-Ilorin road	iv.	P., T.
Patigi, two streams one and three miles to the E. of	v.	P., T.
Patigi, one mile to the E. of	v.	P.
Patigi, tributary of the Kuyi River near	v.	P.
Patigi, swamp on the road to Lah near	v.	P.
Patigi	viii.	P., T M.
Patigi, Niger bank at	viii.	P.
Patigi. Stream between the Residency and the town	viii.	P.
Patigi, Malalase stream near	viii.	P., T.
Patigi, Nyemi River near	x.	M.
Reke	vi.	P.
Rogun, and also south of the Kampe River near Rogun	v.	P., M.
Rogun	vii.	T., P.
Rogun	viii.	T., M.
Rogun, Kampe River near	viii.	P., T., M.
Rogun	x.	P., T., M., L.
Rogun, between Daji and	x.	P., M.
Ruganagaji, west of Lafiagi, in the Egua swamp	iv.	P., T.
Sakpefu, edge of the Niger flats near	v.	P., T.
Sanlu, Kabba Province	vii.	M.
Sukugi	vii.	P., T., M.
Sula, between Magi and Kasagi	vii.	M.
Susonogi, Niger swamp between Gakpan and	v.	P., T M.
Tampa-balogun, Stream between Lafiagi and	iv.	T.
Tsuvun, between Pada and	vii.	P., T.

EASTERN DIVISION—*continued.*

Tutugi, stream on the Rogun-Patigi road	v.	P., M.
Tutugi	x.	P., M.
Yabagi or Yagbagi	vii.	P., T., M.
Yamu Zuru, near Niger swamps	v.	P., T., L.
Yelua, near Lafiagi	viii.	P., T., M.
Zongo, near Lafiagi	viii.	P.
Zumbufu	vii.	T., M.
Zumbufu	viii.	P., T., M.

SOUTHERN DIVISION.

Afon	v.	P., T.
Afon	viii.	P.
Agbamu	ix.	P.
Ajassepo	viii.	P.
Akpa	ix.	P.
Alabi, on the Odo Oyi	ix.	P.
Amonifaza, near Ilorin	ix.	P.
Aredube, on the Oshin River ...	ix.	P.
Aula	ix.	P.
Awsun	ix.	P.
Awtun, between Etan and ...	v.	P.
Awtun. In thick bush around the town	vi.	P.
Aza River, south of Ilorin ...	viii.	P.
Edidi	viii.	P.
Ekan	ix.	P.
Epetu. Thick bush	vi.	P.
Erin. Near the railway line ...	vii.	P.
Eruku	viii.	P.
Etan	ix.	P.
Gama	vii.	P.
Idiemi	v.	P.
Idofian, near	ix.	P.
Idofian, Odo Aweri near	ix.	P.
Idofian, Okagi River near ...	ix.	P.
Idofin	ix.	P.
Igboma	viii.	P.
Igbonla. Thick bush	vi.	P.
Igbowo	ix.	P.
Ikauton	viii.	P.
Illa	v.	P., T.
Illa market	iv.	P., T.
Illotta	ix.	P.
Illotta, Igbo Illotta, bush near ...	ix.	P.
Iloffa. Thick bush	vi.	P.
Iloffa	viii.	P.
Ilorin. On the road to Olobondoroko	viii.	P.
Isanlu, along a stream between Omu and...	v.	P.
Isanlu	ix.	P.
Kanla River, near Obaniswa ...	viii.	P.
Laduba	viii.	P.
Laiyadu	ix.	P.
Obate	vii.	P.
Obo	viii., ix.	P.
Odde, Afon district	viii.	P.
Odo Eku	ix.	P.
Odo Jagu	ix.	P.
Odo Ogbo	ix.	P.
Odota River, on the Ilorin-Obaniswa road	viii.	P.
Offa...	iii.	P.
Offa. In the swamp (Pl. III., fig. i.)	iv.	P.
Offa. Thick patch of bush to the W. of the Residency	iv.	P.
Offa, Oyun River near	viii.	P.
Offa. To the W. of the native town	ix.	P.
Ojuko	ix.	P.
Oke Aba	ix.	P.
Oke Awra	iii., viii.	P.
Oke Illa. At the Illa River ...	ix.	P.
Oken Igbe	vi., viii.	P.
Okeya. In thick bush round Okeya between Ajassepo and Igbadja	vi.	P.
Okun River, on the road to Obaniswa	viii.	P.
Olobondoroko	vii., viii.	P.
Olobondoroko. On the road to Ilorin	viii.	P.
Omedo	ix.	P.
Omu	iii., v.	P.
Omu. Around Omu in thick bush and near a stream ...	vi.	P.
Oquale	viii.	P.
Orimope	viii.	P.
Oro River, between Idofin and Eruku	vi.	P., T.
Osale River, on Ilorin-Obaniswa road	viii.	P.
Osi	v., viii.	P.
Owo, between the Oyi River and	iv.	P.
Owo, between Isanlu and ...	v.	P.
Sakpe	ix.	P.

Fig. 1. The cattle that sicken with trypanosomiasis on the way to the coast are slaughtered and laid out for sale on the roadside.

Fig. 2. Oyun River near Ilorin, showing an actual haunt of *G. palpalis* and *G. tachinoides*.

Fig. 1. Weru River in the dry season: a haunt of *G. palpalis*.

Fig. 2. View from Old Oyo looking towards Ilorin: uninhabited country.

Fig. 1. The fly-belt at Offa; a haunt of *G. palpalis*.

Fig. 2. Sobe Rock, near Ilorin; one of the isolated hills typical of the scenery of Ilorin; *G. palpalis* was taken at the foot of this rock.

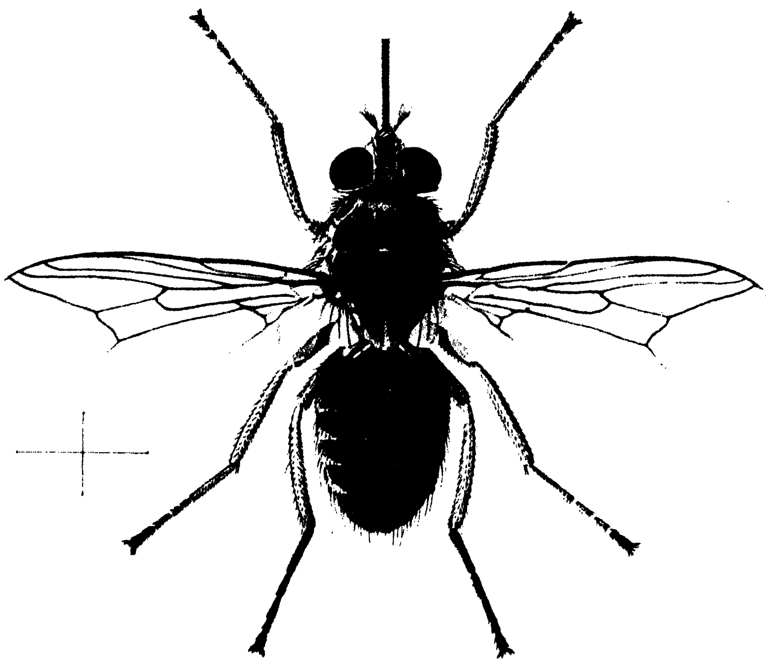
The village of Eri: with dwarf cattle in foreground.

Fig. 1. Path through bush near Jodomo Railway station, frequented by *G. palpalis*.

Fig. 2. A cow of the dwarf breed of cattle found in Nigeria.

Fig. 1. Natives fishing in the Anwa River at Babagba: a spot where *G. palpalis* and *G. tachinoides* occur.

Fig. 2 Oshin River, near Jebba, in the dry season: a haunt of *G. tachinoides*.



A. J. E. TERZI, DEL. BALE & DANIELSSON, LTD

GLOSSINA PALPALIS, R.D., var.

SOME OBSERVATIONS ON THE LARVA OF AUCHMEROMYIA LUTEOLA, F.

By Dr. Robert E. McConnell,
Medical Officer, Uganda Protectorate.

The following are a few observations made on the larvae of *Auchmeromyia luteola* taken in Uganda. The larvae were kept in glass-topped cardboard boxes containing earth. Several attempts were made to feed them on the less hairy parts of puppies but in no case did they make any attempt to draw blood. I then placed some on my own hand. In only one instance was this successful, the details of the feeding being described below.

Meat, crushed ticks, bananas were placed in the boxes at various times, but so far as could be gathered, they were left untouched. By dampening the earth with water every few days larvae were kept alive up to a month. They would probably have lived longer were it not that the exigencies of constant travelling caused their neglect. The small immature larvae however did not seem to grow, those which pupated having been mature, or almost so, at the time of capture. The longest period between capture and pupation was 12 days, and this larva was full of blood when taken and two days later its alimentary tract was still red with blood.

The following records indicate the duration of the pupal stage:—

Larva taken.	*Pupated.*	*Flies emerged.*
September 12th	September 15th	October 6th
,, 12th	,, 15th	,, 9th
,, 12th	,, 16th	,, 6th
,, 12th	,, 17th	,, 7th
,, 12th	,, 17th	,, 9th
,, 16th	,, 28th	,, 16th

The average period between pupation and the emergence of the imago was therefore 21 days, the extremes noted being 18 and 24 days respectively.

I did not observe an actual escape from the pupa-case. A fly shortly after emerging, while the head parts were still soft and mobile, was held between the thumb and forefinger. It kept repeating a movement in which the base of the head first swelled and then precipitated a peristaltic elongating action towards the apex, on the completion of which a projecting or thrusting movement of the anterior half took place, which doubtless was a repetition of the mechanism by means of which the pupa-case had been broken.

The following is a description of the feeding of a larva on the web between my index and middle fingers. A slight though not constant pricking was felt during the experiment. The biting and suctional process was accomplished by four little shakes of the body lasting about one second and which could be distinctly felt. This was followed by a period of rest lasting two seconds.

At end of 3 minutes:—Larva almost perpendicular to the surface attacked, but resting the body against the finger.

12 minutes :—The posterior extremity which had formerly been flat became full and rounded.

14 minutes :—An erecting peristaltic wave of the whole body took place.

17 minutes :—The alimentary tract seemed to be forced posteriorly. The tail end became flat again. A puncture was evident in the finger.

19 minutes :—The tail became full and rounded again; blood was seen in the alimentary tract.

20 minutes :—The erecting movement was repeated. The body seemed nearly full of blood.

26 minutes :—The sucking movements became feebler.

27 minutes :—The posterior end having become flat, again filled out.

27–30 minutes :—Another erecting movement and the tail became flat.

29 minutes :—Still feeding; posterior end full again.

29–30 minutes :—The sucking movement more feeble and taking place at longer intervals.

30 minutes :—Larva straightened out; feeding well again.

30–31 minutes :—Fell partly to one side; tail flat again.

31 minutes :—Almost horizontal; still feebly feeding; tail full.

32 minutes :—Regained perpendicular position; whole body dark, except lateral thickened bands, but tail darkest.

33 minutes :—Fell to almost horizontal position; still feeding, but feebly.

36 minutes :—After partly regaining the upright position it again became almost horizontal.

39 minutes :—Released hold; air bubbles were seen in the body.

The little circular punched-out hole in the finger was bright red, but did not bleed. It was followed by no swelling.

ON A NEW AFRICAN SPECIES OF COCCIDAE.

By J. W. Scott Macfie, M.A., B.Sc.,
West African Medical Staff.

Ceronema africana, sp. n.

Female (fig. 1).—Ovisac formed of thickly felted creamy-white to buff-white secretion ; dorsum highly convex longitudinally and slightly so transversely, with a series of 11 longitudinal and crenulated keels or ridges, of which the lateral ones are very broad and flange-like and arise from points on the body of the female considerably nearer the middle line than any of the others ; sides vertical, with two or three curved or concentric keels similar to those on the dorsum, but

Fig. 1.—*Ceronema africana*, Macfie ; females with ovisacs *in situ* ; very slightly enlarged.

there are also small transverse intervening lines which give the sides of the ovisac a distinctly conchoidal appearance ; interior of ovisac smooth. *Length*, 6·50 to 8·50 mm. ; height, 6 to 7·50 mm. ; width, 6 to 7·25 mm. Old adult female tilted as in Pulvinaria so that the front, which is distinctly produced, is the only portion attached to the food-plant. In some instances the position of the body is almost vertical, and in one example the anal portion projects actually slightly in front of the cephalic margin. Dorsum with a median elongated patch of opaque glassy secretion, the rest nude and dark brown in colour.

Female after maceration in potash—broadly ovate, and usually distinctly produced anteriorly. *Derm* covered irregularly with more or less circular cells (fig. 2 A) with thick walls ; in the centre of each cell a circular aperture and a

minute pore with a narrow canal communicating with it. *Abdomen* covered ventrally with small circular spinnerets especially at the posterior extremity and along the periphery. The main spinning glands (figs. 2 B *a*, 2 C *a*), corresponding to the ridges of the ovisac, placed singly round the margin of the body, just dorsal to the marginal spines. Anal lobes (fig. 2 F) longer than in *C. koebeli*, Green,* each furnished with a variable number of spinose hairs at either pole; ano-genital ring with ten stout hairs. Margin with a close series of short

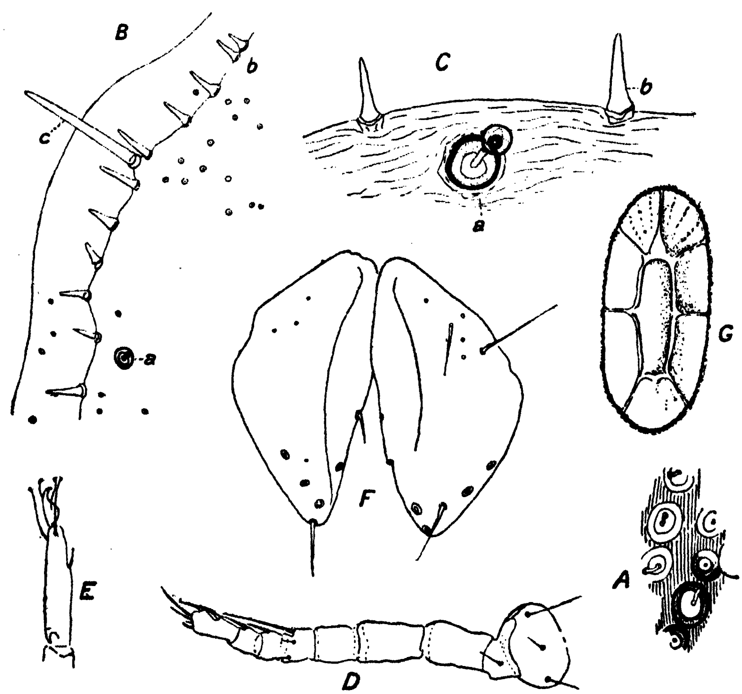


Fig. 2. *Ceronema africana*, Macfie.

Female.—(A) derm-cells; (B *a*) large spinning gland; (B *b*) marginal spines; (B *c*) stigmal spine; (C) spinning gland and marginal spines more highly magnified; (D) antenna; (E) tarsus; (F) anal lobes.

Male.—(G) male puparium.

pointed spines (figs. 2 B *b*, 2 C *b*); a single larger spine (fig. 2 B *c*) marking the stigmatic area. *Antenna* (fig. 2 D) nine-jointed; third and fourth joints considerably longer than the others, the third, fourth, and fifth apparently without any hairs; one particularly long hair is attached to the sixth joint. *Legs* relatively small but well developed; foot (fig. 2 E) with four digitules, dilated distally, claw strongly hooked at the tip and with a minute tubercle on the concave border near the extremity. *Length*, 6·2 to 8 mm.; width 4·5 to 5 mm.

* Coccidae of Ceylon, p. 256, pl. xcvi, figs. 1–16 (1909).

LARVA (taken from the ovisac of the female)—elliptical. Antennae (fig. 3 A) six-jointed, the third joint being the longest; two especially long hairs on the third and sixth joints. Stigmatic area (fig. 3 B) marked by one long and two short spines, which are slightly spatulate at their tips, and a row of three or four daisy-shaped spinnerets (fig. 3 B *a*) leading inwards towards the stigma. Margin with a series of small pointed spines. Legs well developed. Caudal setae (fig. 3 C *a*) very long, in some cases measuring as much as two-thirds of the length of the body; at the base of each seta a group of four spines. Ano-genital ring (fig. 3 C) with six stout hairs.

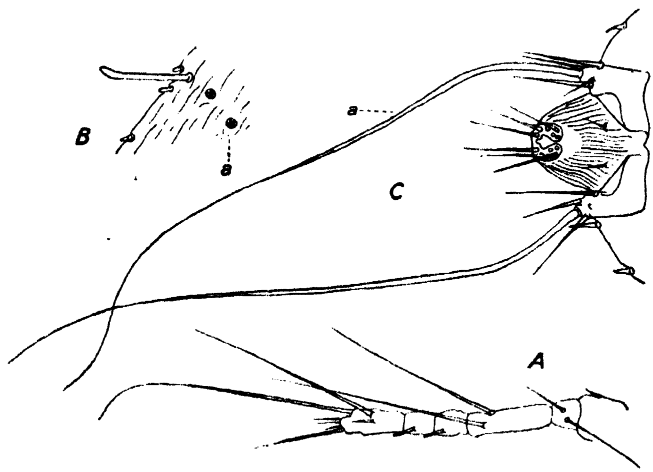


Fig. 3. *Ceronema africana*, Macfie.

Larva.—(A) antenna; (B) stigmal spines; (B *a*) spinnerets; (C) anal segment; (C *a*) caudal setae.

MALE.—*Puparium* (fig. 2 G) glassy opaque white, elongated, with parallel sides; form not differing materially from that of the genus *Lecanium*; margin with an imperfect and irregular fringe of waxy appendages. *Length* 2·5 mm., breadth 1·5 mm.

Adult male unknown.

NORTHERN NIGERIA: Shonga, Ilorin Province, iii. 1912.

Food-plant.—"Pride of Barbados" (*Caesalpinia pulcherrima*, Sw.), a prickly shrub growing to a height of 5 to 10 ft., which, on account of its showy red or yellow flowers, is a favourite in the gardens and compounds of Nigeria.

In the form of the ovisac of the female this species bears a striking resemblance to *Ceronema koebeli*, Green (*l.c.*), but morphologically the latter is very clearly distinct. The distinctive characters in *C. africana* are that the antennae are decidedly stouter, the digitules of the claw are less dilated, the central stigmal spine is considerably longer, and there is a total absence of short spines leading up to the stigmata. Furthermore the derm cells are oval in shape and not "irregularly polygonal" as in *C. koebeli.*

This is apparently the first recorded occurrence of this genus in Africa.

I have to thank Professor Newstead for the greatest kindness and assistance in working out the characters of this species.

Dactylopius (Pseudococcus) virgatus var. **madagascariensis,** Newst., Liverpool University Quarterly Journal, iii, no. 6.

I have to record here this species as occurring plentifully on the young shoots of a tree called by the natives "chedia" (*Ficus sp.*) at Ilorin, Northern Nigeria, in May 1912. This insect has been recorded elsewhere as feeding upon cactus, cocoanut palm, cotton, violets, etc.

This species is also apparently new to the continental African fauna.

ON SOME NONDESCRIPT ANOPLURA AND MALLOPHAGA.

By Bruce F. Cummings.

(*Published by permission of the Trustees of the British Museum.*)

The following notes and descriptions are based on material in the collection of the British Museum :—

ANOPLURA.

Subfamily, Linognathinae.

Genus, Polyplax, Enderlein.

Polyplax pectinata, sp. nov.

This parasite approaches Neumann's *Haematopinus* (*Polyplax*) *maniculatus*, but is immediately recognised by the truncate proboscis, by the "olecranon process" of the hind pair of legs, and by the remarkable "comb" which terminates the abdomen of the ♀. Perhaps a new genus should be made to receive it.

Linear, abdomen about four times the length of the head and thorax together. *Head* very broad, proboscis truncate, its lateral margins diverging to as far as the antennae, behind which the head enlarges at right angles. Post-antennal area rectangular, broad ; the occipital margin a little convex. At each posterior angle a long hair ; on the under surface, at about the level of the antennae, two short bristles, one on each side. *Antennae* of five segments, the first being thick and stout, the second narrower and the longest, the third short, and the fourth broad with a sharp prominence at the post-axial distal corner. Adjoining the prominence a small circular sense-organ which crosses the joint and occupies part of the base of the terminal segment. The latter is longer than the third or fourth, and has several spines at the end. *Thorax* broader than the head and broader behind than in front. A large flattened spheroidal spiracle at each lateral margin. Sternal plate piriform. The first pair of legs much shorter and more slender than the rest, the coxae inserted almost longitudinally. In the third pair, the coxae are very large and broad, separated by an interval from the two anterior pairs of coxae. The third femur bears an "olecranon process" in the form of a broad scalloped plate on the post-axial margin. This curves downwards and the concave side of the plate shows radiating lines or grooves. The third pair of claws are broad, rounded plate-like. *Abdomen* very long, broader than thorax. Dorsal and ventral surfaces with transverse rows of widely spaced hairs, more than one row to each segment. Pleurae large, broad, on the lower margin deeply cleft, with two bristles in the fork of the cleft. In the ♂ the eighth pair of pleurae are very long, the lower margin of each extending in two long pointed processes or limbs beyond the end of the last segment ; there are two long bristles in the fork of the cleft. In the ♀ the processes of the eighth pair of pleurae are longer than the others, but they do not extend beyond the end of the abdomen. The hind margin of the terminal tergite in the ♀ is peculiar, being drawn out into a frill or comb of long finger-shaped processes, each of which is surmounted by a long bristle. Last segment in ♂ conical, truncate at

the tip, with a small hair at each corner; genital armature short, only just extending into the penultimate segment. *Chitin* everywhere shows a pronounced scaly appearance under a high power. The "scales" are imbricated and occur on the head, thorax and abdomen and may be detected on the clear chitin between the sclerites.

Length (in mm.), ♂, 1·40, ♀, 1·85; head, ♂ ♀, 0·15; thorax, ♂ ♀, 0·2; abdomen, ♂, 1·05, ♀, 1·5; greatest width, ♂ ♀, 0·4.

HOST: *Epimys surifer*, Mill.

MALAY PENINSULA: Biserat, Jalor, 6. vii. 1901 (*Annandale & Robinson*).

The specimens were, unfortunately, too damaged for complete description.

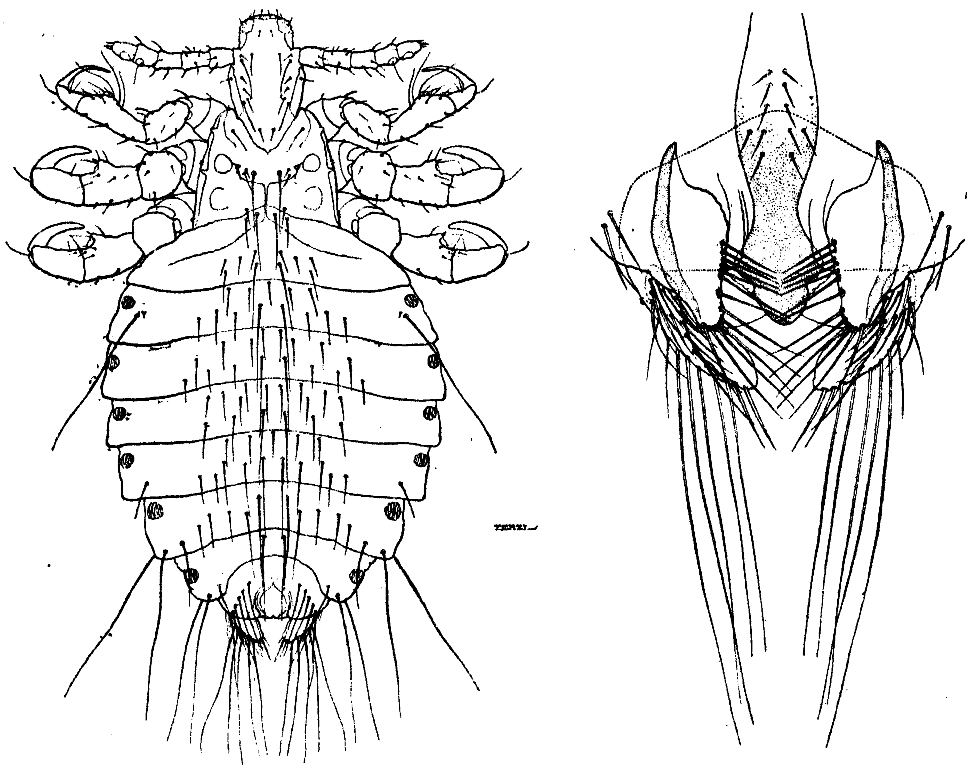


Fig. 1.—*Linognathus limnotragi*, Cummings, ♀, and the underside of the last segments (♀).

Genus LINOGNATHUS, Enderlein.

Linognathus limnotragi, sp. nov.

The new form is distinguished by the broad truncate proboscis, suggestive of *L. gazella*, Mjöberg; but *L. limnotragi* is broader, and differs in the position of the brown taches on the preantennal area of the head, the arrangement of the bristles and hairs being also quite different.

Head thick, stunted, broad and short in front, truncate at the tip of the proboscis, which bears four distinct hairs and is very rugose, with small tubercles. Two deep brown taches on each side of the preantennal area of the head, which extend a little around the anterior corners of the head, but do not meet; on the

ventral surface they are united by a transverse band. The head is wider behind the antennae and narrows again towards the thorax, which is V-shaped to receive it. On the upper surface, two longitudinal rows of hairs, meeting behind. A single hair in the lateral margin midway between antenna and thorax ; between the antennae, near the middle line, two small hairs ; more anteriorly, between the lateral taches, another pair of small hairs. Under surface almost bare, except for two long bristles inside the lateral margins, behind the antennae, and two more in front, closer together. *Antennae* long and thick, second segment a little longer than the first, and a sense-organ on the fourth and the fifth. *Thorax* broad and short, with two long hairs on the upper surface near the middle ; spiracles large, with three small hairs on the inner side of each of them ; a short bristle at each anterior corner. First pair of legs slender, with a long pointed claw ; hinder pairs larger, with broad, permanently curved, prehensile claws. *Abdomen* plump, broad, longer than head and thorax together. The third segment as in *L. breviceps*, Piaget, and others, with a long hair on each side, and a minute one at the base of each long one. Segments VI and VII at their lower angles carry on each side two long bristles, one dorsal and one ventral ; rows of hairs running transversely, but confined to the median areas, are found on both dorsal and ventral surfaces. In the ♂ the last segment on the upper surface has a large semicircular row of hairs ; genital armature large and projecting on a terminal papilla. In the ♀ the gonopods are large and thickly bristled, with a transverse row of hairs running between them. The sides of the last segment are formed into two distinct ventro-lateral, strongly chitinised pieces, each with a thick exterior margin bearing a row of long bristles. An elongate genital tache between the gonopods and extending some way beyond them behind, in shape like a slipper (crepiduloid), with two stout bristles, one on each side of it in front, and between these two short longitudinal rows of small hairs.

Length (in mm.), ♂, 1·475, ♀, 2·125 ; head, ♂, 0·3, ♀, 0·325 ; thorax, ♂, 0·175, ♀, 0·2 ; abdomen, ♂, 1·00, ♀, 1·6 ; greatest width, ♂, 0·475, ♀, 0·8.

HOST : *Limnotragus gratus*, Sel. (in the Zoological Gardens, Regents Park).

CONGO.

Linognathus caviae-capensis (Pallas) (figs. 2 and 3).

Pallas, in his Spicilegia Zoologica, Fasciculus II (Mammalia), 1767, describes and figures, as *Pediculus caviae capensis*, a parasite from the Cape Hyrax (*Procavia capensis*), probably identical with specimens of Anoplura from the same mammal in the collection of the British Museum. His description and his figures agree with the species described below in the sexual dimorphism, in the contour of the head, and in the long hairs on the abdomen.

Ehrenberg (Symbolae Physicae, 1828, Decas Prima, page 'f') gives the following brief diagnosis of a species, *Pediculus leptocephalus*, from the Syrian Hyrax (*P. syriacus*), which he regards as differing from Pallas's insect:—"Capite antennarum porrectarum articulis duobus superato gracili, oculis distinctis nullis." From this it appears probable that the species on the Syrian Hyrax is distinct.

Giebel (Insecta Epizoa, 1874, p. 47) unites the two forms under the name *Haematopinus leptocephalus*, though he remarks upon Ehrenberg's opinion as to their distinctness and though he had apparently nothing to go upon except the

slender diagnoses of the original authors. Giebel misquotes Ehrenberg and then suggests that Pallas's species, according to his figure, has quite the appearance of the swine louse (*H. urius*). Piaget (Les Pediculines, 1880, p. 656) copies the suggestion, which is clearly an error, if for no other reason than the much smaller size of Pallas's parasite.

As the description by Pallas is inadequate, a further account is appended. Unfortunately I have no specimens from the Syrian animal for comparison, but assuming that they belong to another species, the specific name *leptocephalus* must be given to them, while the name *caviae-capensis* may be retained for Pallas's

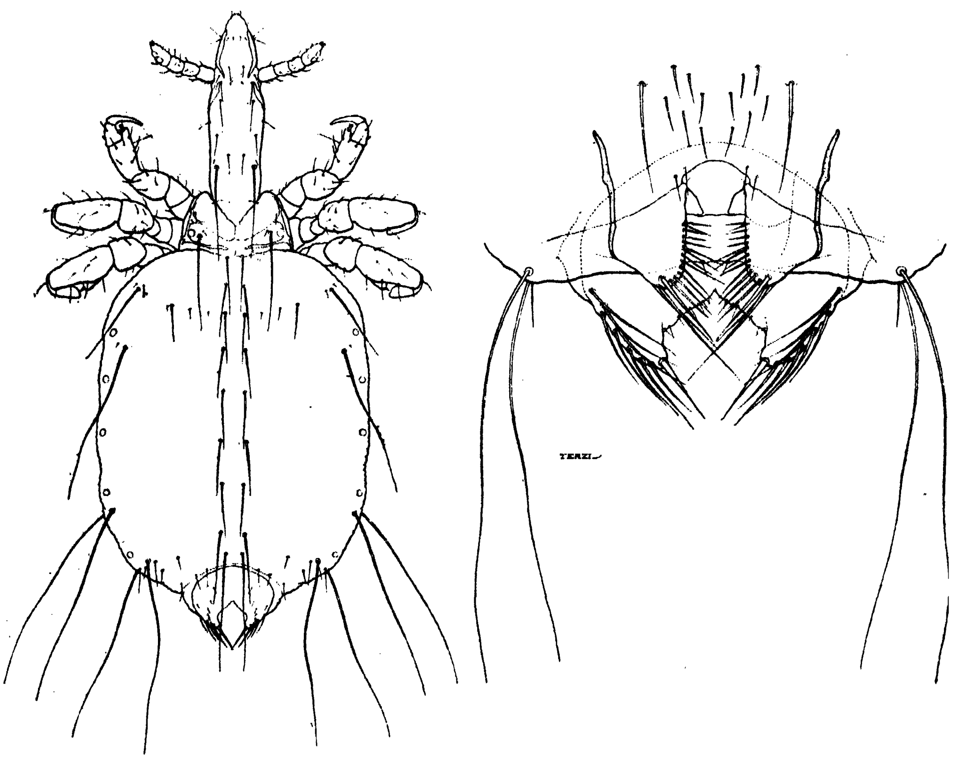


Fig. 2.—*Linognathus caviae-capensis* (Pallas), ♀, and the underside of the last segments (♀).

insect, although, strictly speaking, he used no name at all, but published descriptions of two animals, a *Taenia* and the *Pediculus*, under the Latin title (not name) of "Pediculus et Taenia Caviae capensis."

Head long, narrow, quadrilateral in cross-section, with four sharp edges; sucking apparatus correspondingly elongate. Preantennal area conical with 2 deep brown taches on each side, which curve in across the head towards each other at about the level of the antennae. On the dorsal surface behind the antennae, two longitudinal rows of hairs, the last one in each row being very long; two hairs on each side at the base of the antennae; two more a little further forward nearer the middle line; still further in front, another row of only six hairs, the two outside ones being on the extreme margin; two hairs at the top of the proboscis. On the ventral surface, two hairs in front of the antennae and

two immediately behind. *Antennae* of four joints, the last two segments being fused into one large swollen segment carrying two partially fused sense-organs half-way along the postaxial margin. *Thorax* small, short, broader than the head, anterior margin V-shaped. A long hair on the upper surface on each side near the spiracle; two more closer together on the hind margin. *Abdomen* oval. Two longitudinal rows of hairs running down the middle of both dorsal and ventral surfaces, two hairs above and two below on each segment; on the dorsal surface of the second segment, however, there is a transverse row of eight hairs; at the sides of the ultimate and antepenultimate segments two very long hairs; on dorsal surface of the second and third segments, a little way in from the lateral margin, a long bristle on each side. Terminal segment of ♂ with two

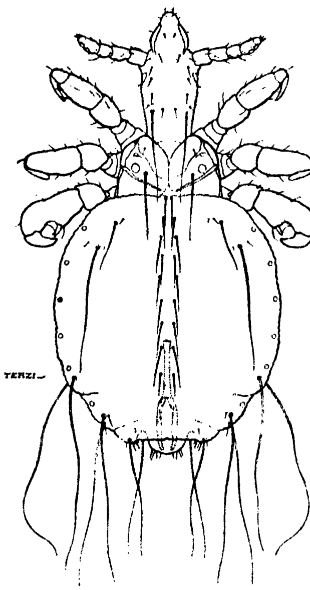


Fig. 3.—*Linognathus caviae-capensis* (Pallas), ♂.

deep bays, one on either side of the rounded posterior margin. Gonopods long, parallel-sided, the lower inner angles rounded and produced.

♂. In this sex the head is shorter, the sides converging a little towards the thorax, and the abdomen is shorter and rounder.

Length (in mm.), ♂ 1·25, ♀ 1·825; head, ♂ 0·45, ♀ 0·575; thorax, ♂ ♀ 0·25; abdomen, ♂ 0·55, ♀ 1·00.

Host: the Cape Hyrax (*Procavia capensis*, Pallas); from the Zoological Society's Gardens, Regent's Park.

MALLOPHAGA.

Genus Trimenopon, nov.

In being a two-clawed parasite on mammals, this interesting South American insect resembles the Mallophaga of the genera *Boopia*, *Heterodoxus* and *Latumcephalum*. But whereas these three genera are typical of the Australian region

and occur principally on Marsupials, the new genus is from Paraguay, and was taken on *Cavia aperea*. It is a robust, spiny insect, with large, prothoracic "wings," recalling *Trincton*, just as *Heterodoxus* stands close to *Menopon*.

The genus is distinguished not only by the prothoracic "wings," but by the form of the ♂ genitalia and by the proportional lengths, the head and thorax together being almost as long as the abdomen.

Trimenopon echinoderma, sp. nov. (fig. 4).

Head similar to that of *Menopon*, broader than long. Premaxillary area semicircular; behind the maxillae the lateral margins curve outwards in a bend and continue to diverge as far as the postero-lateral angles, which are acute;

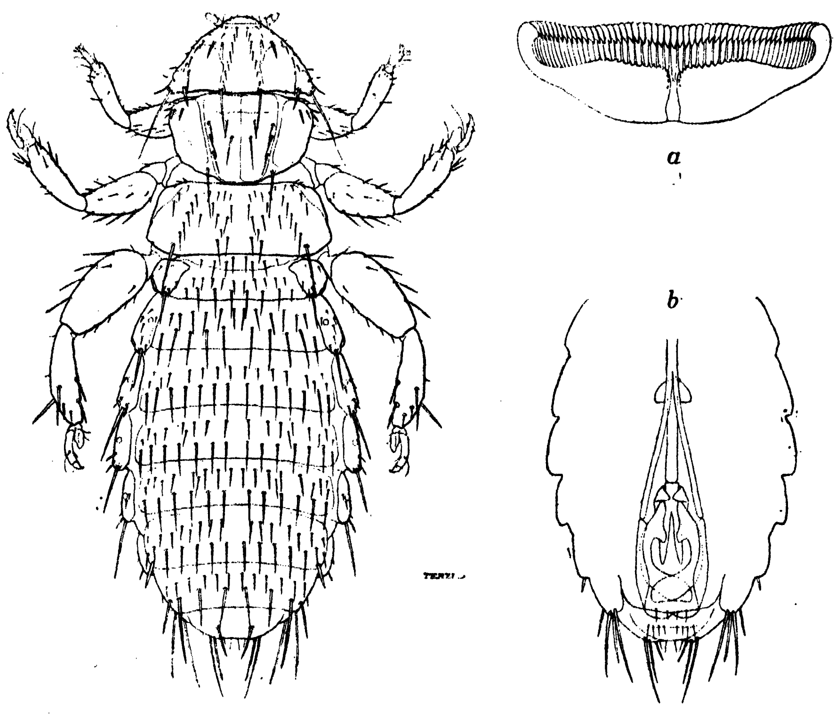


Fig. 4.—*Trimenopon echinoderma*, Cummings, ♀; *a*, the gastric teeth; *b*, ♂ sexual apparatus.

occipital margin more or less straight. Two rows of hairs run longitudinally over the dorsal surface of the head; in front of each temporal fossa on the dorsal surface is a powerful spine; a transverse row of small hairs in front, at the level of the maxillary palpi, the two outer ones being on the extreme margin. Several spines along the lateral margins of the head, and on the postero-lateral corners stands a group of very stout spines, one being exceptionally long. Under surface of the head with a raised central area; at the postero-lateral angles of this a long bristle and three short ones in line in front

of it and situated along the lateral margin of the area; numerous other small hairs arranged symmetrically; several minute hairs around the clypeus. Maxillary palpi long, joints almost equal. Labium with two lobes on each side bearing hairs. Hypopharynx with two well-developed fringed lobes in front, a central bar of chitin running out from a broad plate behind. *Antennae* club-shaped, five-jointed, concealed in fossae. *Thorax*: pronotum with well developed lateral "wings," elegantly narrowed behind; two longitudinal brown bands of thicker chitin divide the pronotum into three areas; the bands curve in and unite at the posterior margin; a median groove is present; a few short sharp spines close together on the upper side of the "wings." In the middle area of the pronotum a row of four hairs, and another row of four hairs just behind; on the posterior margin of the pronotum, two long bristles with two smaller ones in front of each. The metanotum shorter, but broader, than the prothorax, being broadest on the abdomen. Spines arranged roughly in the form of an M; other spines arranged as indicated in the figure. Thoracic sternal areas decorated with stout spines, which on the prosternum are confined to the lateral areas. A somewhat complicated endoskeleton: two stout bars running in like clavicles towards the sternum from the "shoulders" of the pronotum; in the metathorax there is a bifid bar, one limb forming the margin of the metanotum and the other sloping down at the side to the ventral surface. *Legs* strong and spiny; onychium large, with the edge crenulate. Hind pair of legs stouter than the rest, with stouter spines, particularly on the tibiae. The tarsi with one or two long silky hairs. *Abdomen* broadest beyond the middle, ovate. Each tergite and sternite with two rows of stout hairs arranged transversely, those in the posterior row being longer than those in the anterior; tergite I with only two hairs in the first row. On the ventral surface, the outside spines of the second row of each segment very large and brown in colour. Pleural angles of the last few segments more pronounced and carrying longer bristles. Terminal segment rounded in the ♂, the genital armature peculiar (fig. 4*b*). In the ♀, segment VIII with a semicircular plate ventrally covering the genital aperture; IX ventrally with an oblique row of bristles on each side, and behind each row an oblique band of chitin which runs backwards towards the vulva, where it bifurcates. The sexes are alike, except as regards the terminal segments.

Length (in mm.), ♂ ♀, 2·20; head, ♂ ♀, 0·3; thorax, ♂ ♀, 0·65; abdomen, 1·25; greatest width, ♂ ♀, 0·75.

HOST: *Cavia aperea*, Erxleben.

PARAGUAY: Villa Rica, 6. xi. 1910 (*F. Posner*). Presented by the Hon. N. Charles Rothschild.

In specimens of both sexes, prepared with potash, a dense row of teeth and two dentate flaps (fig. 4*a*) are visible through the integument of the first or second abdominal segments in the position occupied by the crop. Snodgrass, in his "Anatomy of the Mallophaga" (Occas. Papers Californian Acad. of Sciences, vi, 1899, p. 145), does not refer to the presence of gastric teeth in this order, so that perhaps it is worth while that attention be directed to them in *Trimenopon*.

Genus LAEMOBOTHRIUM, Nitzsch.

Laemobothrium opisthocomi, sp. nov. (fig. 5).

This well characterised species from the Hoatzin, of British Guiana, is distinguished by a pronounced sexual dimorphism, the frontal margin of the head in the ♂ being excavated, as in the genus *Akidoproctus*, while in the ♀ it is only concave. The mandibles of the ♂ are also longer and narrower than those of the ♀. Abdomen of the ♀ long, lanceolate at the end; of the ♂, shorter and abruptly rounded apically. Upper surface smooth and shining, of an almost uniform brown colour, bare, except at the lateral margins.

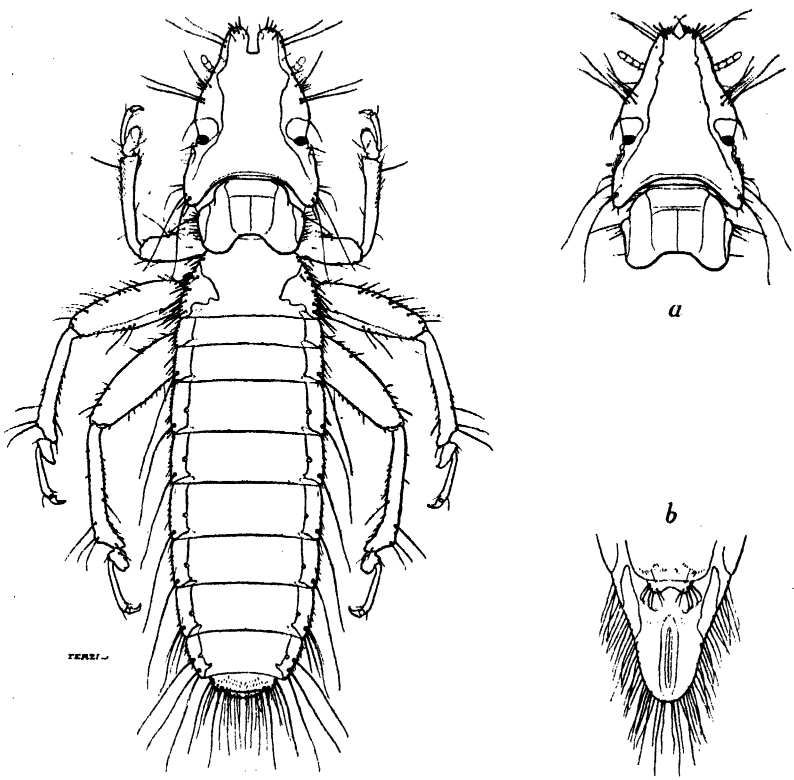


Fig. 5.—*Laemobothrium opisthocomi*, Cummings, ♂; *a*, head and pronotum of ♀; *b*, the underside of the terminal segments of ♀.

Head elongate, very narrow in front, broadening out before the antennae; antennal fossae circular, deep; temples much produced behind so as to embrace the anterior narrower area of the prothorax. On each promontory of the bay on the frontal margin is a group of about five thick blunt bristles, with three or four finer hairs; the bay bare of hairs; on the exterior or lateral margin of each of the promontories, two long hairs and a short one a little further back; a group of long hairs on each side behind the maxillae, three of which are much longer than the rest; on the temples the usual series of rows of short hairs, ridges and

comb-like structures present in other species of the genus ; two long hairs at the posterior angles of the head. *Thorax:* pronotum narrow in front and rounded, enlarging abruptly at the sides, concave in the metathorax, the postero-lateral angles being large, rounded and prominent ; a T-shaped impression in the upper surface. Three short hairs on each side on the anterior margin behind the head, difficult to detect without a strong lens ; about a dozen hairs on the lateral margin of the broadened posterior area of the prothorax. On the under side, an elongate sternal plate, broad in front, with a shallow bay between the two rounded anterior angles. Metathorax narrow in front and much constricted at the junction with the prothorax ; a linear median impression above, a closely set row of lateral bristles and a sternal plate shaped like a spear-head and pointing backwards. *Legs* long, unicolorous. The first pair of femora short and thick, the second pair twice as long, third pair still longer. The first pair of tibiae with a dense row of bristles and one long hair on the distal half of the outside margin, the tibiae of the other legs with three long hairs on the distal extremity of the outside margin. *Abdomen* broad and long, segments closely fitted together, so that the lateral margins are unbroken and continuous, and the smooth bare shining upper surface scarcely interrupted by the sutures. Lateral margins of thick chitin are more clearly visible from below. In the ♂ the spiracle in each segment lies in a notch in the inner margin of the lateral border. The segments are of different lengths, I being the shortest, II a little longer, and each succeeding segment longer than that which precedes it. In the ♀, IX is lanceolate, long and elegantly curved ; in the ♂ it is short, rounded and broad at the end, being received into the concavity of the posterior margin of the preceding segment. Attached to almost the whole of the posterior margin of the second sternite is a short soft flap or "flounce," 0·25 mm. in length, grooved and furrowed longitudinally. On the lower corner of each segment a long hair, not at the angle, but just inside the margin on the dorsal surface. Upper surface of the lateral margins of each segment with a series of short hairs, one (sometimes two) of these being a little longer than the rest ; on the lower side of the lateral margin of each segment, four or five small hairs ; at the lower corners of segment VII a long bristle on the dorsal side, another on the ventral and several at the edge ; VIII similar ; in the ♀, IX has a fringe of moderately long, closely spaced hairs all round the edge, and on its dorsal surface, half-way down and a little distance from the edge, four hairs in a group, one long one and the others smaller in descending ratio. Lower lip of the vulva supported by two long ill-defined slips of brown chitin, one on each side ; the upper lip partially concealed, produced into a quadrilateral flap, stretched between two stout brown rods of dense chitin ; each rod with several long wiry bristles at the tip ; a transverse curved slip of chitin connecting the base of each rod with the lateral margin of the segment. In the ♂ the terminal tergite is short broad and elliptical, with several long hairs at the sides and two very long hairs, one on each side of the posterior margin ; across its breadth a series of minute bristles ; the whole area of the tergite divided up by a median and a transverse pale line into four taches, the two anterior ones being the shortest ; just within the terminal aperture is a somewhat bilobed lappet, with four hairs on each lateral lobe. Terminal sternite longer than and overlapping the tergite, a median longitudinal line dividing it into two areas.

Length (in mm.), ♂, 8·45, ♀, 10·1; head, ♂ ♀, 2; thorax, ♂ ♀, 1·7; abdomen, ♂, 4·75, ♀, 6·4

HOST: the Hoatzin (*Opisthocomus cristatus*).

BRITISH GUIANA (presented by the Hon. N. C. Rothschild).

Laemobothrium is the parasite *par excellence* of the birds of prey, though it also occurs in *Gallinula*, *Fulica* and *Psophia*, and has been reported from the ostrich.

Miscellaneous Notes.

Dochophorus on Bombus.

B. Wanach (Ent. Rund. 1910) records the transport of a *Philopterus* by *Ornithomyia avicularia*, L., and Mitzmain (Philippine Agric. Rev., v, 12th December 1912) reports the Anopluran, *Haematopinus tuberculatus* (Nitzsch), as attaching itself in its earlier stages to the legs of *Lyperosia*. It is perhaps of interest to record here in this connexion that the British Museum collection contains a fragmentary specimen of an unidentified species of *Dochophorus* taken from *Bombus hyperboreus*, from Hayes Sound, 79 N. Lat.

Heterodoxus longitarsus (Piaget) (=*H. macropus*, Le Souëf and Bullen).

In the "Victorian Naturalist" for February 1902, p. 159, Messrs. S. A. Le Souëf and H. Bullen give a summary description and a rough figure of an Amblyceran which they name *Heterodoxus macropus*, found on the kangaroo. Examples of this parasite which Mr. Le Souëf presented to the British Museum agree almost *in toto* with Piaget's species *Menopon longitarsus* ("Les Pédiculines," p. 504), from *Helmaturus giganteus*. Prof. L. G. Neumann (Archives de Parasitologie, xv, 1912, p. 353) records *M. longitarsus* from a kangaroo in the Jardin des Plantes. I have been unable to compare *H. macropus* with the type of *M. longitarsus* but Piaget's full description and figure and Neumann's figure of the head are sufficient to put the matter beyond doubt. The Australian authors comment on its likeness to the genus *Menopon*, but in consequence of the fact that its host is a marsupial mammal and not a bird (as in almost all other MENOPONIDAE) they decided to found the new genus *Heterodoxus* for it; which should perhaps be allowed to stand, especially as I find the hypopharynx differs markedly in structure from that of other MENOPONIDAE so far examined. *Heterodoxus longitarsus* (Piaget 1880) from a mammal is mentioned by Piaget with *Colpocephalum truncatum* (on *Phascolomys fossor*), and *Menopon extraneum* (on *Cavia cobaya*), also from mammals. The British Museum collection contains specimens of *H. longitarsus* from the Wallaby (N. Queensland), from *Corone australis* (Victoria), from the dog (Borneo), and the jackal (Somaliland), so that this species is able to exist on a variety of hosts, in many parts of the world.

Hybophthirus notophallus, Neumann.

This peculiar parasite from the equally peculiar Cape Ant-eater, *Orycteropus afer*, was described in 1909 both by Enderlein and by Neumann. The latter's description under the name *Haematopinus notophallus* was the first to be published, in the Jahrbücher des Nassauischen Vereins für Naturkunde in Wiesbaden; while Enderlein's description under the new genus *Hybophthirus* appeared,

according to a note received from Gustav Fischer, on 29th December 1909, in the Denkschriften der Medizinisch-Naturwissenschaftlichen Gesellschaft, when the Jahrbücher had been out for more than a month.

Haematopinus tuberculatus (Nitzsch).

There are several specimens of this species in the collection of the British Museum from the camel, which is further evidence in support of a suggestion thrown out by Prof. L. G. Neumann that the "Pidocchio del Cammello," figured by Redi (1668, Esperienze intorno alla generazione degl' insetti) and named *Pediculus cameli* by Linnaeus, is *H. tuberculatus*. I have also examined several specimens from the Chinese water buffalo.

FURTHER NOTES ON AFRICAN CULICIDAE.

By F. W. Edwards, B.A., F.E.S.

(Published by permission of the Trustees of the British Museum.)

The following notes consist of corrections and additions to my previous papers on African Culicidae. Several errors have become apparent, due either to carelessness or insufficient study of the material available, or insufficiency of the material itself. These are corrected. One or two apparently new species have been received and are now described; the description of one or two others, owing to the scanty material and doubtful systematic position, is left for a future paper.

Anopheles ardensis, Theo.

Reference to *Myzomyia pyretophoroides*, Theo. (Mon. Cul. iv, 1907, p. 48), which is a synonym of this, was accidentally omitted.

Toxorhynchites barbipes, sp. nov.

♂. Closely resembles *T. brevipalpis*, Theo., in all respects except that the *first joint of the hind tarsus is thickly clothed with long black hair.* This is a most striking character and is not found in any other member of the genus, or, indeed, in any other mosquito. It hardly seems possible that this could be a mere individual variation, and I therefore regard it as a distinct species, though it seems to differ in no other way from *T. brevipalpis.*

Uganda: 1 ♂ (type), Mpanga Forest, Toro, 4,800 ft., 13–23 xi. 1911 (*S. A. Neave*).

Presented to the British Museum by the Imperial Bureau of Entomology.

Banksinella taeniarostris, Theo.

It was previously suggested that this might be a variety of *B. luteolateralis*, Theo. This is improbable. The hind femora were wrongly stated to be "all dark above"; in reality they are yellow at the tip and have a yellow dorsal line on the basal two-thirds; in this the species much resembles *B. punctocostalis*, Theo., in which the black ring of the hind femora is near but *not at* the apex, as previously stated. Both *B. taeniarostris* and *B. punctocostalis* have the abdomen black above, the lateral yellow spots being produced towards the middle of segments 5, 6 and 7. In *B. luteolateralis* the abdomen usually (though not invariably) has prominent yellow basal median as well as lateral spots on each segment. Theobald's *B. chrysothorax* is the male of *B. taeniarostris* and not of *B. luteolateralis*.

Banksinella luteolateralis var. **albicosta** nov.

♀. Differs from typical *B. luteolateralis* as follows:—Yellow scales of head, thorax, abdomen and wings replaced by creamy-white ones; scales of mesonotum only slightly darker in the middle, so that the whole mesonotum appears whitish

to the naked eye. The wings have the *apical two-fifths of the costa with whitish-yellow scales*, and similarly coloured scales are also present on the second and fourth veins, extending over almost the whole of the upper fork and the base of the lower.

This variety approaches Theobald's var. *albothorax*, which has a whitish mesonotum, only a little darker in the middle, but has the wings as in the typical form. The var. *pallida*, Theo., also resembles var. *albicosta* in some respects, but it has the entire costa and the middle of the mesonotum dark. If it were not for these two varieties which somewhat resemble it, I should not have hesitated to class this new form as a distinct species, and such it may eventually prove to be.

British East Africa: 1 ♀ (type), near Wangi, coast of Mainland, 21–22 ii. 1912 (*S. A. Neave*); 2 ♀, Juba River, ix.–x. 1911 (*Dr. C. L. Chevallier*); 1 ♀, Mombasa Island (*Dr. W. J. Radford*).

All these specimens have been presented to the British Museum by the Imperial Bureau of Entomology.

Ochlerotatus (Finlaya) furcifer, nom. n.

Mansonia nigra, Theo., Second Rept. Wellc. Lab., p. 80 (1906).

Diceromyia africana, Theo., Fourth Rept. Wellc. Lab., p. 151 (1911).

Three female specimens of this curious and interesting species have been taken at Weshiang, Gold Coast, on the River Dainsu, 10 miles north-west of Accra, by Dr. H. F. Hamilton. They agree with Theobald's excellent description of *D. africana*, except that the palpi have two indistinct white rings; one of the specimens has very narrow irregular white bands on the abdomen which touch the bases of the segments in the middle. The agreement with *M. nigra*, also, is nearly but not quite perfect, as there are no apical white bands on the abdominal segments, and the fore and mid claws are toothed. Apart from the last point, these are unimportant differences, and do not in my opinion indicate that two distinct species have been described. As all the legs of the type of *M. nigra* are lost, Theobald's statement that the claws are simple cannot be confirmed or corrected.

As the group *Finlaya*, to which these species belongs, has been included by the writer under *Ochlerotatus*, the specific name has to be changed, as Giles' *Taeniorhynchus niger* (1904) is an *Ochlerotatus*, and the name *africanus* has been used by Theobald for other species which are now included in *Ochlerotatus*. The *Finlaya* group is distinguishable by the very broad wing-scales, the short terminal joint of the male palpi and the rather large and non-retractile eighth segment of the female abdomen. It is quite possible that *Finlaya* will eventually be recognised as a good genus, in which case the name *nigra* will have to be reinstated. For the present, however, the toothed claws and tapering abdomen of the female seem to be sufficient justification for the inclusion of this group in *Ochlerotatus*; the eighth abdominal segment is in a similar condition in *Stegomyia*.

The name *furcifer* is suggested by the forked male claspers, which have been figured by Theobald. The writer's reference of this species to *Mansonioides*, without the examination of specimens, was an error. The group seems to be intermediate between *Ochlerotatus* and *Mansonia*.

Ochlerotatus durbanensis, Theo.

Additional localities:—ABYSSINIA: Mt. Fantali, 4000 ft., 21 viii. 1908 (*Dr. R. E. Drake-Brockman*). UGANDA: L. Bogosu, 19. xi. 1912, numerous on rim of crater morning and evening (*Dr. R. E. McConnell*).

The Uganda specimens differ from those from Durban and Delagoa Bay in having the yellow apical markings of the abdominal segments forming complete bands instead of lateral spots.

Ochlerotatus geniculatus, Olivier.

Culex geniculatus, Olivier, Encycl. Méthod. vi, p. 134 (1791).

Culex lateralis, Mg., Syst. Beschr. i, p. 5 (1818).

Elsewhere (Ent. Mo. Mag., May 1913) I have given in full my reasons for the above substitution. After careful consideration it seems advisable to refer back the two specimens named previously *O. ornatus*, Mg. (Bull. Ent. Res. iii, p. 21) to *O. geniculatus*, Oliv., and accept as the true *O. ornatus*, Mg., the species so designated by Ficalbi, of which I have recently received a pair from Hungary. The North African specimens constitute a distinct variety of *O. geniculatus*, differing from the European form in having complete white bands (though narrow in the middle) on the abdominal segments, and flat scales on the scutellum. Until more specimens come to hand, however, it does not seem advisable to name this form.

Ochlerotatus salinus, Fic.

Culex salinus, Ficalbi, Bull. Soc. Ent. Ital., xxviii, p. 29 (1896).

This is the species referred to in the writer's earlier papers as *O. nemorosus*, Mg. It differs from the true *nemorosus* in having dark and light scales intermixed on the wings, femora, and tibiae; it breeds in salt-marshes, whereas *O. nemorosus* is almost confined to woods and heaths.

Ochlerotatus quasiunivittatus, Theo.

An examination of mounted male genitalia of specimens from Salisbury, Mashonaland, and Nairobi, British East Africa, led to the quite unexpected conclusion that the insects from these localities are distinct species, as the genitalia differ very markedly. The name *quasiunivittatus* must be retained for the Mashonaland form, while the East African form may be referred, for the present at least, to *O. dentatus*. In this species the hind claws may or may not be toothed. *O. caliginosus*, Grah., from Ashanti, though appearing distinct from being smaller and much blacker, has genitalia almost exactly like those of *O. dentatus*, and may eventually have to be ranked as a variety of it. The genitalia of *O. cumminsi*, Theo., are also very similar.

Aëdes (Skusea) pembaensis, Theo.

This was previously (Bull. Ent. Res. iii, p. 13.) included with doubt in *Howardina*, as only Theobald's type, in very bad condition, was known. Recently however a small series of females has been received from Mr. S. A. Neave, who took them near Siyu, Patta Island, British East Africa, 19–20. ii. 1912. In

general appearance these specimens closely resemble the Oriental *Aëdes butleri*, Theo., and the Australasian *A.* (*Skusea*) *similis*, Theo.; and though the male remains unknown, there is every probability that the present species belongs to *Aëdes* in the restricted sense. The simple claws of the female characterise the subgenus or group *Skusea*, to which *A. pembaensis* belongs, and which is differentiated from the *Culex* group (not always very clearly) by the form of the abdomen.

In *A. pembaensis* the scutellum is clothed with flat *black* scales; the head has mostly black scales, a few round the eyes and lateral patches of variable size being white. Mr. Neave thinks the species must breed in salt water, as the district in which he found it is extremely dry. It is, he says, a very troublesome biter.

Taeniorhynchus versicolor, sp. nov.

♀. *Head* light brownish with golden-yellow narrow scales and dark brown upright ones. Palpi about one-quarter as long as the proboscis, with mainly yellow scales, and some black scales at the middle and apex. Proboscis yellow, black at the tip, with a few scattered black scales. Antennae rather light brown, basal joint almost orange, a few dark scales on the first two joints. *Thorax* clothed rather sparsely with golden-yellow scales, which extend on to the scutellum; bristles dark brown. Integument dull brown, lighter in colour on the shoulders; pleurae light brown with a darker brown stripe. *Abdomen* banded with purple-black and golden-yellow scales, the former occupying rather more than the apical half of each of segments 2–7. *Legs* with mixed black and yellow scales; black rings at the apices of the tibiae and first three tarsal joints; last two tarsal joints entirely black; hind tibiae with a broad black ring near the middle; the scales of the hind tibiae not projecting. *Wings* clothed with long and rather narrow scales; these are for the most part blackish, but a few yellow ones are mingled with them, and on the stems of the fork cells, the basal half of the third vein, and the apices of the first and second veins, the scales are almost all yellow. The wing thus has two yellow patches, one just beyond the middle and the other close to the tip, which are conspicuous to the naked eye. The costa and wing-fringe are entirely dark. First fork-cell a little longer than the second, its stem about half as long as the cell.

♂. Resembles the female, but the dark scales are much more extensive, so that the yellow patches on the wings, so conspicuous in the female, are practically obliterated, and the tarsi are mainly blackish; the dark bands on the abdomen occupy quite two-thirds of each segment. Palpi exceeding the proboscis only by about half the length of the last joint; the last two joints are short and about equal in length; the first two joints are black-tipped, the last almost entirely black. The larger claws of the fore and mid legs each bear a single long tooth.

BRITISH EAST AFRICA: 1 ♀ (type), Nairobi, 16 vii. 1912 (*T. J. Anderson*); UGANDA: 2 ♂♂, 1 ♀, Mbarara, in house, 21 ix. 1912, and 1 ♀, Kabula, 11 xii. 1912 (*Dr. R. E. McConnell*). All the specimens have been presented to the British Museum by the Imperial Bureau of Entomology.

This species most resembles *T. fuscopennatus*, but differs in its dull thoracic integument, broad blackish abdominal bands, yellow patches on the wing of the female, shorter terminal joints to the male palpi, etc. *T. fuscopennatus* has a shiny thorax, bare scutellum, the dark bands of the abdomen narrow and often

absent, the dark and light scales of the wings evenly mixed, and salient scales on the hind tibiae. Dark specimens of *T. annetti* have somewhat similar wing markings, but that species has different thoracic scaling, narrower black rings on the tarsi, yellow costa and different venation.

Mansonioides uniformis (Theo.).

Panoplites uniformis, Theo., Mon. Cul. ii, p. 180 (1901).
Panoplites africanus var. *reversus*, Theo., Mon. Cul. ii, p. 189 (1901).
Panoplites australiensis, Giles, Gnats Ed. 2, p. 355 (1902).

This differs markedly from *M. africanus* in the male genitalia (fig. 1), the harpagones being much longer and thicker. It can also be distinguished by the coloration of the thorax and legs. The thorax has a more reddish tinge than in *M. africanus*, and the two longitudinal pale stripes are unbroken and more greenish. There is often in addition a median pale stripe (of the same greenish

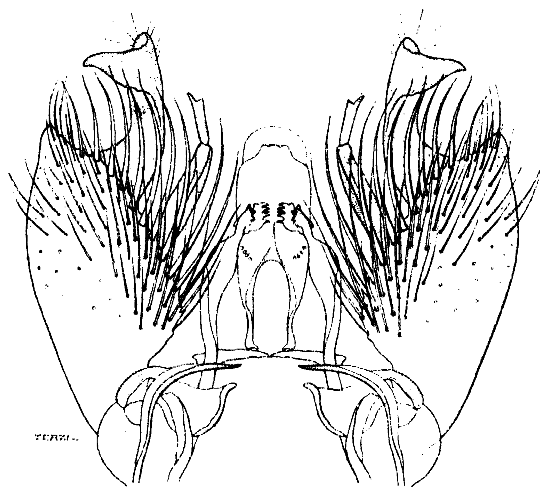


Fig. 1.—*Mansonioides uniformis* (Theo.) ; hypopygium from beneath.

colour) extending forwards from in front of the scutellum ; the type of *P. africanus* v. *reversus* is so marked. The five blotches on the femora are more ochreous and less well defined than in *M. africanus*, and the spots on the tibiae are also yellowish-ochreous instead of white, while the ground-colour of the legs is lighter, so that all the markings are much less sharply defined. Both species, however, vary somewhat in this respect.

The following localities for *M. uniformis* in Africa can be definitely confirmed from a re-examination of specimens (mostly female) :—

ANGOLA (*Dr. C. Wellman*) ; BECHUANALAND : Lake Ngami (*R. B. Woosnam*) ; PORTUGUESE E. AFRICA : Delagoa Bay (*Dr. J. F. Sant' Anna*) ; BRITISH E. AFRICA : Nzoia River (*W. Kennedy*), Lake Gango (*C. W. Woodhouse*), Malindi (*E. Brand*) ; NYASALAND : (*Dr. C. W. Daniels, F. O. Stoehr*), Zomba (*Dr. Gray*), Fort Johnston (*Dr. R. Bury, Dr. A. H. Barclay*), Rifu (*S. A. Neave*), Chiromo (*Dr. J. E. S. Old*) ; UGANDA : Busoga (*Dr. Hodges*),

Entebbe (*Dr. Moffat*, *Dr. Low*), shore of Lake Victoria Nyanza (*Captain A. D. Fraser*), Bussi (*Dr. C. A. Wiggins*), Muzizzi and Mugidi Rivers, Bunyampaka, Mohokya and Kayansa, Semliki River, all in Toro (*Dr. R. E. McConnell*), Koki Country, S.W. Buddu (*S. A. Neave*); SUDAN: Bahr-el-Ghazal (*Dr. Cummins*); N. NIGERIA: Amara, R. Benue (*J. McFarlane Pollard*), Maiduguri (*Dr. W. D. Inness*), Baro (*Dr. A. Ingram*), Lokoja, Derri and Yelwa (*Dr. J. J. Simpson*); S. NIGERIA: Lagos (*Dr. W. H. Sieger*), Yaba, Lagos (*Dr. W. M. Graham*), Aro (*Dr. J. J. Simpson*); SIERRA LEONE: (*Dr. Arbuckle*), Torma (*Dr. J. J. Simpson*); GOLD COAST: Accra (*Dr. W. M. Graham*), Weshiang, R. Dainsu (*Dr. H. F. Hamilton*, *Dr. A. C. Connal*).

I have studied the genitalia of male specimens from Ceylon and the Malay States, and find them identical with those of African specimens.

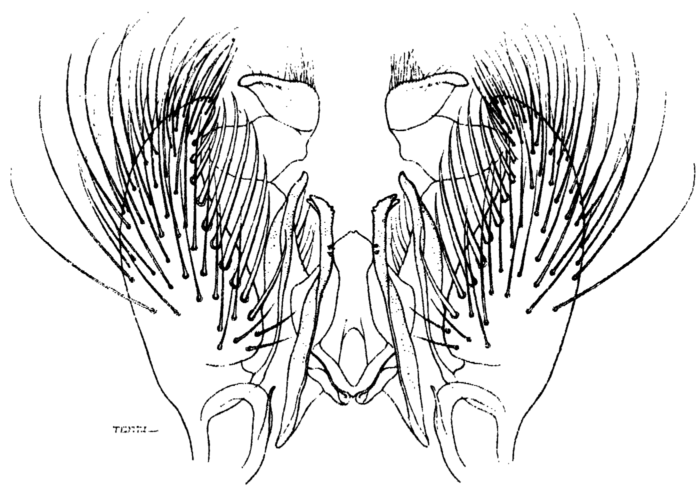


Fig. 2.—*Mansonioides africanus* (Theo.): hypopygium from beneath.

Mansonioides africanus (Theo.).

Panoplites africanus, Theo., Mon. Cul. ii, p. 187 (1901).
Mansonia major, Theo., Mon. Cul. iii, p. 270 (1903).
Mansonia nigerrima, Theo., Mon. Cul. v, p. 450 (1910).

The pale stripes of the thorax are twice interrupted, but more distinctly so in some specimens than in others; the thoracic integument is usually darker than in *M. uniformis*, and the palpi of the female have a much more distinct white tip. The structure of the male genitalia is shown in the figure (fig. 2). As in the case of *Culex pipiens* and *C. fatigans*, the genitalia of the two African species of *Mansonioides* differ mainly or only in their basal parts (harpes and harpagones). *M. major* was described from a flattened, but typical female specimen.

M. nigerrima may perhaps rank as a good variety; it is much darker than the type: the thorax is darker, with hardly a trace of pale markings; the dark scales of the wings are much more numerous than the light, and the white rings

at the bases of the hind tarsal joints are much narrower than in typical *M. africanus.* The male genitalia, however, do not differ in any way. This form has up to the present only been found in Uganda.

The following distribution may be confirmed: BECHUANALAND: L. Ngami (*R. B. Woosnam*); BRITISH EAST AFRICA: near Wangi, coast of mainland (*S. A. Neave*), Magogoni Swamp, near Witu (*S. A. Neave*), Nzoia River (*W. Kennedy*), Kisumu (*Dr. A. Mouat*); NYASALAND: Fort Johnston (*Dr. A. H. Barclay, Dr. R. Bury*), Fort Maguire (*Dr. A. H. Barclay*), Zomba (*Dr. Gray,*) Bua River and Chiromo (*Dr. J. E. S. Old*), Karonga, mouth of Nkumbaleza R. and near Kota Kota (*S. A. Neave*); N. RHODESIA: junction of Luangwa and Mpamadzi Rivers (*S. A. Neave*), Mburuma (*O. C. Silverlock*); UGANDA: Entebbe (*Dr. Moffat, Dr. Low, Capt. Grieg*), Chagwe (*Capt. A. D. Fraser*), Muzizzi, Mugidi and Lami Rivers, Ndaiga, Kidongo, Bunyampaka, Mohokya and Kikorongo, all in Toro (*Dr. R. E. McConnell*), western shore of Lake Victoria Nyanza, Buddu (*S. A. Neave*); BELGIAN CONGO: Coquilhatville and Yumbi (*Dr. A. Yale Massey*); SUDAN: Bahr-el-Ghazal (*Capt. Cummins*); N. NIGERIA: Lokoja (*Dr. E. A. Chartres, Dr. C. F. Watson*), Baro (*Dr. A. Ingram, Dr. J. J. Simpson*), Yelwa, Mama, Zungeru and Derri (*Dr. J. J. Simpson*); S. NIGERIA: Yaba, Lagos (*Dr. W. M. Graham*), Siluko (*Dr. A. H. Wilson*), Yewa River, Badagry (*Capt. L. E. H. Humfrey*), Obubra Station, Ikom District (*Dr. W. S. Clarke*), Bende and Ikpe (*Dr. P. H. Macdonald*), Oshogbo (*Dr. T. F. G. Mayer*), Aro, Ere, Onitsha and Asaba (*Dr. J. J. Simpson*); GOLD COAST: Bole (*Dr. A. Ingram*), Weshiang, R. Dainsu (*Dr. A. C. Connal, Dr. H. F. Hamilton*); SIERRA LEONE: Torma (*Dr. J. J. Simpson*); GAMBIA: (*Dr. Burdett*).

Var. *nigerrimus*: UGANDA: Mpumu (*Sir D. Bruce*), Entebbe (*Dr. Moffat*), Kafu River, near Hoima, Koki Country, S.W. Buddu, and Mabira Forest, Chagwe (*S. A. Neave*).

In many districts *M. africanus* seems to be commoner than *M. uniformis*, but it has not been found outside the Ethiopian Region.

Culex pipiens, L.

Culex pipiens, L., Syst. Nat. Ed. x, p. 602 (1758).
? *Culex zombaensis*, Theo., Mon. Cul. ii, p. 143 (1901).
Culex varioannulatus, Theo., Mon. Cul. iii, p. 198 (1903).
Culex azoriensis, Theo., Mon. Cul. iii, p. 210 (1903).
Culex osakensis, Theo. (♀ only), Mon. Cul. iv, p. 439 (1907) [♂ = *C. fatigans*].
Culex quasiguiarti, Theo. (♀ only), Mon. Cul. v, p. 374 (1910) [♂ = *C. pallidocephalus*].

This species is common at Nairobi and other places in British East Africa.

The males from these localities differ in no way from the typical *C. pipiens* of Europe, but strangely enough the females are very variable in markings, which is not the case with European specimens; sometimes the abdomen has well-marked yellowish-white bands, sometimes these are reduced to inconspicuous pale lateral spots, so that the whole dorsal surface of the abdomen appears blackish. Every gradation occurs between these two extremes. In these dark varieties the

reddish thorax and the venation generally give fairly safe clues to the specific identity. The only absolutely reliable character, however, is the structure of the male genitalia (fig. 3). *C. quasiguiarti* was certainly described from females of *C. pipiens*; the type of *C. zombaensis* is either the dark form of *C. pipiens* referred to above, or a corresponding variety of *C. fatigans*, the venation more resembling that of the last-named species, though I prefer to regard it as the former; it is, however, a matter of no consequence, as both species occur in East Africa.

In mounting genitalia I find it advantageous to use the following method: The tip of the abdomen is carefully snipped off with a pair of sharp-pointed scissors, and placed in 10 per cent. caustic potash, which is then just brought to the boil. The specimen is then washed well with water, transferred to absolute

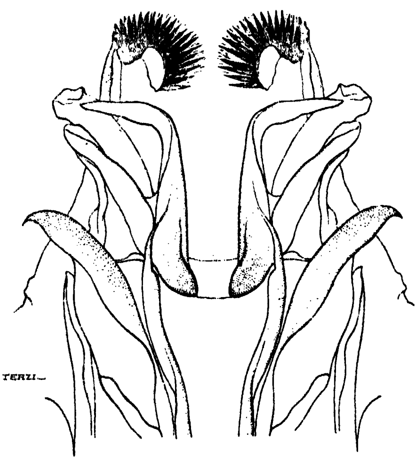


Fig. 3.—*Culex pipiens*, L.

Basal parts (harpes and harpagones) of hypopygium from above. The large side pieces are not shown, as they exactly resemble those of *C. fatigans*, and are essentially similar to those of *C. pallidocephalus*, except that their lateral processes bear only one leaf-like appendage.

alcohol for two or three minutes, thence to clove oil, where the hypopygium is separated from the terminal abdominal segments, and is then transferred to a drop of stiff Canada balsam on a small strip of transparent celluloid, without any coverslip, which is placed on the pin below the stage bearing the insect from which the genitalia were removed. The hypopygium should be carefully adjusted when placed in the balsam, so that good dorsal and ventral views can be obtained, either for examination or for drawing. If this is not done, however, it is quite easy to remount the specimen at any time.

I find that if specimens of complex genitalia are mounted on ordinary glass slides with coverslips over them, the arrangement of the parts is apt to become so much altered that without considerable experience they are hardly recognisable. The figures given by Messrs. Dyar & Knab for *Culex pipiens* and *C. fatigans* (Proc. Ent. Soc. Wash. 1909, pl. 2, fig. 4, and pl. 1, fig. 1) were made from slide preparations, and the differences between them and those here given are mainly

due to that circumstance. The method of mounting described above has, in addition to much greater reliability, the considerable advantage of keeping the mount and the rest of the specimen together. The figures here given (except figs. 5 and 6) have been prepared from such mounts.

Culex fatigans, Wied.

C. fatigans, Wied., Auss. Zweifl. Ins., p. 10 (1828).
C. quasipipiens, Theo., Mon. Cul. ii, p. 136 (1901).
C. fouchowensis, Theo., Mon. Cul. ii, p. 137 (1901).
? *C. reesii*, Theo., Mon. Cul. ii, p. 145 (1901).
? *C. sericeus*, Theo., Mon. Cul. ii, p. 147 (1901).
C. osakensis, Theo. (♂ only), Mon. Cul. iv, p. 439 (1907).
C. christophersi, Theo., Mon. Cul. iv, p. 453 (1907).
C. quinquefasciatus, D. & K. (? *nec* Say), Proc. Ent. Soc. Wash. xi, p. 34 (1909).
C. goughii, Theo. (♂ only), U.S. Afr. Dept. Agric., First Rept. Vet. Res., p. 268 (1911).

The types of *C. reesii* and *C. sericeus* are in Dr. Rees' collection at Hong Kong, but though I have been unable to examine them, I have little doubt that they are

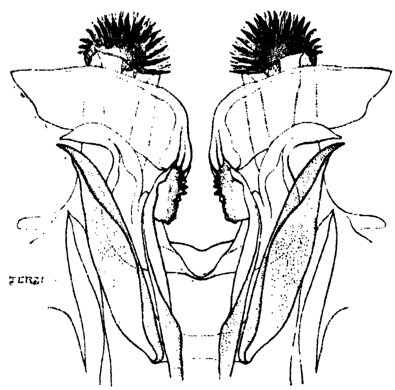


Fig. 4.—*Culex fatigans*, Wied.
Basal parts (harpes and harpagones) from above.

C. fatigans, which is very common in that locality. The male types of *C. quasipipiens*, *C. fouchowensis*, *C. osakensis*, *C. christophersi* and *C. goughii* I have examined, and they are certainly *C. fatigans*. There seems to be insufficient justification for Dyar and Knab's replacement of the name *fatigans* by *quinquefasciatus*, Say, and it is therefore reinstated, for the present at least. Say's description of the thorax of *C. quinquefasciatus* indicates an *Anopheles* rather than a *Culex*, and Wiedemann, who stated that he had seen most of Say's original specimens, referred the species to *Anopheles*. Howard examined some of Say's specimens in the Vienna museum, all of which were *Culex* of the *pipiens* group, but there is nothing to show that these are the examples on which the description was based.

This species is difficult to distinguish from *C. pipiens* until the male genitalia are mounted and examined microscopically; when this is done, however, the differentiation is easy.

As in *C. pipiens*, the harpagones are divided into *four* plates (not three, as Dyar and Knab say), but these have a very different structure and arrangement (fig. 4). Males are usually somewhat smaller than those of *C. pipiens*; females also are a trifle smaller on the average, and have the upper fork cell shorter than in *C. pipiens*.

Culex fatigans has a wider distribution in Africa than has been stated previously. I can confirm its occurrence in the following localities from examination of male specimens:—

CAPE COLONY: Cape Town; TRANSVAAL: Onderstepoort (*Dr. Theiler*); NATAL: Pietermaritzburg, Durban (*Dr. S. R. Christophers*); NYASALAND: Zomba (*Dr. C. W. Daniels, Dr. Gray*); BRITISH EAST AFRICA: Mombasa (*Dr. J. D. McKay, S. A. Neave*), Nairobi (*H. J. Mackinder*); ZANZIBAR: Zanzibar Island (*Dr. W. M. Aders*), Pemba Island (*Dr. R. O'Sullivan Beare*); SOMALILAND: Bulhar (*Dr. R. E. Drake-Brockman*); UGANDA: Entebbe (*Dr. Low*); SUDAN (*H. H. King, Dr. A. Balfour*); BELGIAN CONGO: Leopoldville (*Dr. Dubois*); N. NIGERIA: Lokoja (*Dr. C. F. Watson*), Sokoto (*Dr. J. M. Dalziel*); GOLD COAST: Accra (*Dr. W. M. Graham, Dr. A. C. Connal*).

Fig. 5.—*Culex pallidocephalus*, Theo.

Hypopygium from beneath (slide preparation). The *two* leaf-like appendages to the lateral processes of the side pieces are an unusual feature for a *Culex*, and may not be normal in this species.

Culex pallidocephalus, Theo.

C. pallidocephalus, Theo. (♀ only), First Rept. Wellc. Lab. p. 73 (1904) [♂ = *C. decens*].

C. stoehri, Theo., Mon. Cul. iv, p. 419 (1907).

C. quasiguiarti, Theo. ♂ only), Mon. Cul. v, p. 374 (1910) [♀ = *C. pipiens*].

This species is quite distinct from *C. pipiens* and *C. fatigans*, and is not very difficult to identify. The thorax, instead of being almost uniformly reddish

brown, is dark brown, clothed mainly with dark brown scales, but with a variable number of yellowish ones distributed as follows : on the margins of the posterior third or half of the mesonotum ; in front of the scutellum ; and sometimes in two more or less defined spots near the middle of the mesonotum, connected with the pale patch in front of the scutellum. The hind tibiae usually have a much more distinct yellowish white spot at the apex than is found in *C. pipiens* or *C. fatigans*. The abdomen of the female is very variable in its markings ; usually it has distinct yellowish basal bands of even width on each segment ; these bands may be slightly expanded in the middle, but are more often contracted, being occasionally reduced to lateral spots. The genitalia (fig. 5) have the harpes with a large basal projection, the harpagones being divided into three untoothed plates.

SUDAN : Sennar (*Dr. A. Balfour*) ; UGANDA : Mpumu (*Sir D. Bruce*), Entebbe (*Dr. Low*), Kasala, Chagwe and Kampala (*Capt. A. D. Fraser*), Bembadalada (*Dr. C. H. Marshall*) ; BRITISH EAST AFRICA : Njoro and Nairobi (*T. J. Anderson*), Nassisi Hills, 20 miles north of Mumias (*S. A. Neave*), southern slopes of Mt. Elgon (*S. A. Neave*), eastern slopes of Aberdare Mts. (*S. A. Neave*), Laikipia and near Lake Naivasha (*W. Kennedy*) ; NYASALAND : Zomba (*Dr. J. E. S. Old*), Upper Shire (*Dr. J. B. Davey*), Fort Maguire (*Dr. A. H. Barclay*).

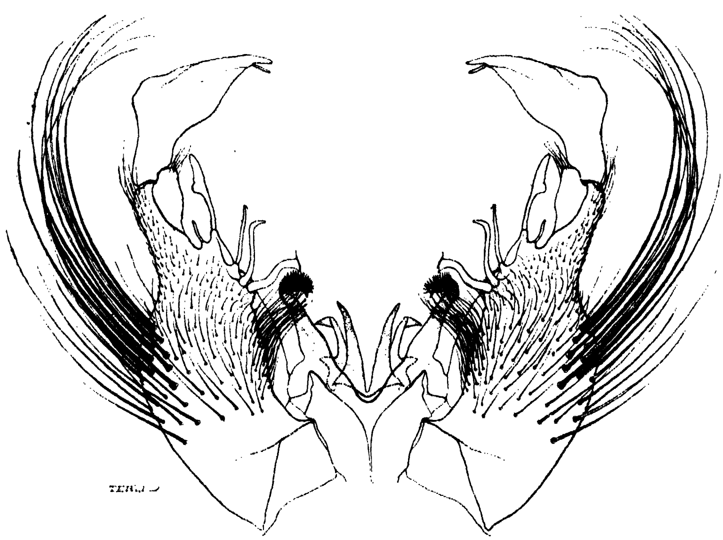


Fig. 6. *Culex mirificus*, sp. n.
Hypopygium from beneath (slide preparation).

Culex mirificus, sp. nov.

Resembles *C. pallidocephalus* so closely that, apart from the genitalia, I can detect no differences whatever. The male genital organs however are totally different in every part (fig. 6)—much more so than are, for example, those of

C. pallidocephalus from *C. ager* or *C. tipuliformis*, which could not possibly be confused. If there were only one specimen it might have been regarded as a remarkable monstrosity or perhaps a hybrid; the occurrence of two other similar specimens makes both these hypotheses, especially the former, improbable. How the females of *C. pallidocephalus* and *C. mirificus* may be distinguished I cannot say.

BRITISH EAST AFRICA: 1 ♂ (type), Njoro, 28 i. 1912 (*T. J. Anderson*), 2 ♂, L. Nakuru, 20 ii. 1911 (*Dr. H. A. Bödeker*).

Ten females taken by Dr. Bödeker at the same time and place as the males may be either this species or *C. pallidocephalus*. The three males and five females have been presented to the British Museum by the Imperial Bureau of Entomology.

Culex decens, Theo., and **C. invidiosus,** Theo.

The genitalia have the harpes with an even larger basal projection than in *C. pallidocephalus*; the harpagones are divided into three plates, of which the second is toothed.

Culex simpsoni, Theo.

The genitalia resemble those of *C. decens* and *C. invidiosus*, but the third plate of the harpagones is not distinctly separated from the second, which is toothed otherwise than in the two species named. *C. simpsoni* varies a good deal in size; it closely resembles *C. univittatus*, except that the tibiae are without the pale stripe; the coloration of the thorax is the same in the two species. This similarity has led to confusion; the specimen which Theobald selected for his male type of *C. univittatus* is really *C. simpsoni*, as also is the specimen referred to by the writer (Bull. Ent. Res. iii, p. 32), as apparently a *C. univittatus* lacking the tibial stripe.

Culex univittatus, Theo.

As in the three species last considered, the harpes have a very large basal projection; the harpagones are divided into only two plates, the second very difficult to see; it is untoothed, though emarginate at its tip. The side-pieces and claspers of all species of *Culex*, except such abnormal ones as *C. mirificus*, resemble one another extremely closely, and usually it is only in the small basal parts that specific differences can be made out.

In this species the femora sometimes show traces of white lines such as are seen in *C. tipuliformis*; these are particularly evident in some specimens from Nairobi (*T. J. Anderson*).

Culex hortensis, Fic.

Culex hortensis, Ficalbi, Bull. Soc. Ent. Ital. xxi, p. 27 (1889).

Maillotia pilifera, Theo., Mon. Cul. iv, p. 274 (1907).

Prof. Ficalbi has kindly sent me some specimens of *C. hortensis*, which have enabled me to give the foregoing synonymy. Blanchard makes *C. hortensis* a synonym of *C. geniculatus*, Oliv., but I cannot accept this, as it seems to me that Olivier's original description clearly indicates *Ochlerotatus lateralis*, Mg.

Cyathomyia fusca (Theo.).

The genus *Cyathomyia* proposed by de Meijere (Ann. Jard. Bot. Buitenzorg, ser. 2, supp. iii, p. 921, 1910) is evidently the same as Theobald's *Protomelanoconion* (Mon. Cul. v, p. 462, 1910), though it appears that *C. jenseni*, Meij., and *P. fusca*, Theo., are distinct species, I learn from Prof. de Meijere that the part containing his description of *Cyathomyia* was published on 6th June, 1910, while the fifth volume of Theobald's Monograph did not appear till July, 1910. The more euphonious name *Cyathomyia* can therefore be substituted for *Protomelanoconion* ; it is doubtful, however, whether the genus should be kept distinct from *Culex*.

Hodgesia sanguinis, Theo.

The British Museum series of this species contains two males; they very closely resemble the females, except in some tarsal modifications. The front tarsi are simple ; the middle tarsi have the last joint bent backwards, but the fourth joint is without a tuft of scales ; the hind tarsi have on their two last joints a fringe of long scales very much like that of *Eretmopodites chrysogaster*.

Hodgesia cyptopus, Theo.

Theobald's type is a male, not a female. The different tarsal characters (viz. :— a tuft of scales on the fourth joint of the middle tarsi, hind tarsi simple) will readily distinguish it from *H. sanguinis*.

NOTES ON INSECT PESTS IN ANTIGUA.*

By H. A. Ballou, M.Sc.

Entomologist to the Imperial Department of Agriculture, British West Indies.

(Plates VIII and IX.)

The principal object of my visit to Antigua, during December 1912, was to study an outbreak of the twig borer of limes† which had been reported by the Superintendent of Agriculture from two localities in the island.

At the time of my visit, owing to recent pruning, there were only occasionally infested branches to be seen, but these were in sufficient number to enable me to form a very good opinion of the nature of the attack and of the general habits of the insect.

The attack on a lime branch apparently always begins on a small twig. I am not able to say whether the twig on or in which the egg is laid is dead or dying at the time of egg-laying ; but in every instance of attack observed by me, both in the field and in specimens forwarded, the twig has been found entirely eaten out, the dead interior connecting with the tunnel in the larger branch from which the twig springs. This branch is always more or less girdled by the tunnel of the grub. The girdling seems to be the first thing done by the grub after completing the destruction of the smaller twig and it results in the death of the branch beyond the point of the girdle. The tunnel does not circle the twig in such a manner as to cut it off completely, but the direction is rather in a spiral, so that as the injury to the branch becomes more and more felt, it breaks down and is usually left hanging. The entire grub and pupa stages are passed within this branch, the adult beetle only issuing from the dead branch some time after emerging from its pupal condition.

The length of the life-cycle is not known. The number of eggs laid by a single female, and the other food-plants on which they are laid, are also still to be learned. With regard to the length of life-cycle, it may safely be said to be comparatively long, since specimens have been found, both larva and adult, in lime twigs which had apparently been dead for a long time, and it seems likely from what we know that this insect begins to feed in living wood.

It is possible that this insect has occurred as a pest of limes in Antigua for some time but has been overlooked. It is also probable that it has a considerable range of food-plants from which renewed attacks on limes may be experienced from time to time. The presence of this insect, however, should not, in my

* [Extracted from a Report submitted to the Secretary of State for the Colonies by Dr. Francis Watts, C.M.G., Commissioner, Imperial Department of Agriculture for the West Indies.—Ed.]

† [Specimens of this insect have been forwarded for identification by Dr. Francis Watts ; it proves to be *Elaphidion mite*, Newman, a Longicorn of the family Cerambycidae. The species has also been recorded from St. Thomas, St. Bartholomew, St. Kitts, Guadeloupe and Brazil.—Ed.]

opinion, prevent the development of the lime industry in Antigua, as it ought to be a fairly easy pest to control. Within a very short time from the beginning of the attack the grub injures the branch in which it is to complete its development to such an extent as to make the injury very conspicuous. First of all the leaves wilt, then discolour and dry up ; about this time the branch breaks at the point of girdling and usually hangs in the tree, forming a very conspicuous notice of the presence of the beetle (Plate VIII).

The remedy to be employed is therefore obvious. Any dying branch on which the leaves are curling up or turning yellow should be carefully examined for the presence of the borer, and if the grub can be found it may easily be dug out or the branch cut off sufficiently far back toward the tree to ensure the removal of the grub. It is more likely that the attacked branches will most often be detected after the breaking down has occurred and then the point at which the branch should be cut is clearly indicated. When the branch has broken the grub will always be found in that part of it beyond (or outside of) the break. If all these broken branches in which the grubs occur can be collected and burned, say at intervals of one month, it ought to be possible so far to reduce the numbers of this insect that it would no longer be a pest.

The loss of the attacked branches in the first instance, is, of course, an important item from the lime-growers point of view ; but if this system of collecting is carefully carried out, there will probably be very little infested material to collect after the first two or three times, because the destruction of all the developing grubs over a period of three or four months will very largely preclude the development of further broods of the insect.

The lime twig borer is different in appearance and in habit from the lime bark borer (*Leptostylus praemorsus*), which has at times been plentiful in Dominica and is known to occur in several other islands. The latter lives entirely under the bark, the attack generally beginning in the vicinity of a patch of dead bark caused by bad pruning or other injury. Its tunnels sometimes extend into living tissue and very rarely enter the centre of the stem. The attacks of this insect usually occur on the larger branches and the main stem, often near the ground-level where the plant has been injured by hoe or cutlass.

The attacks of the twig borer, on the other hand, always occur higher up in the tree, among the smaller branches and twigs. The branches which are girdled and break off are usually not larger than one inch in diameter, generally $\frac{5}{8}$ or $\frac{3}{4}$ of an inch. Occasionally, however, branches larger than one inch have been found girdled ; some of them were broken off (Plate VIII), while in others, either the injury was sufficient to kill the branch above without its breaking off at the point of attack, or the attack has been stopped and the tunnel filled with gum. It is not possible to say exactly what arrested the progress of the grub in forming these tunnels, but it may be that the amount of gum secreted by the plant was sufficient to cause the death of the insect before the injury was extensive enough to cause the death of the branch.

In several localities the orange red scale or California red scale, *Chrysomphalus* (*Aspidiotus*) *aurantii*, was observed in such abundance and under such conditions that it appeared to be doing very serious damage. Young limes two or three years old, are being killed by it (Pl. IX, fig. 1) and in another older lot of trees,

of, say, ten or twelve years of age, this scale was so abundant as to be causing serious injury. Where the trees are oldest (some 30 or 40 years) many have died out and others are dying.

In the case of the older trees, the infestation is often more severe, but the trees being better established have not actually died to quite the same extent as noticed amongst the younger ones. A characteristic feature of the attack of this red scale is that the scales often, if not generally, completely cover the lime fruits before the attack on the leaves and branches is serious enough to attract attention on the part of the casual observer, although a planter accustomed to dealing with this insect would perhaps be aware of its presence some time before this happens.

At the time of my visit these limes had experienced, in common with Antigua generally, a most severe drought. I am of opinion that this scale-insect is essentially a dry weather scale, that is to say, in dry situations it develops and spreads much more rapidly than under conditions of moisture. I am not aware that there is any fungus associated with moist periods or moist conditions which exercises a check on this insect, and must only conclude that the young are probably very easily washed off the plant by heavy rains while they are still in a free, moving condition.

One conspicuous result of severe attack on the lime fruits is that they split open, and this splitting is possibly to be accounted for in the following way. Enormous numbers of these minute insects sucking the juices from the skin of the lime cause it to become incapable of growth, and when, on the advent of rain, the fruits attempt to increase toward their normal size the pressure produced by the growth of the interior of the lime causes the skin to burst.

The occurrence of the orange red scale (*A. aurantii*) has been recorded several times since Mr. H. M. Lefroy first mentioned it in the report on his visit to Antigua in August 1900. Mr. Lefroy expressed in strong terms the danger from this pest. I mentioned it in my report on my visit in 1906, and again in my report in 1911.

I believe this insect to be the cause of the most serious injury from which the limes are suffering, and in the absence of efficient natural control, some artificial remedy must be used to enable the limes to recover. Accordingly, I arranged with Mr. Tempany for certain trials to be made in the use of insecticides, suggesting "Scalo" prepared according to Mr. Moore's formula, the application being made by means of the Autospray, a compressed air sprayer.

Other scales which were noted on limes during the visit to Antigua are as follows:—Purple scale (*Lepidosaphes beckii*), snow scale (*Chionaspis citri*), lantana bug (*Orthezia insignis*) and West Indian red scale (*Selenaspidus articulatus*). It is of interest that the green scale was absent, or at least not noted, and that there was very little black blight. The scales mentioned are of general occurrence on limes in Antigua, but at this time they were not present anywhere in unusual numbers.

At one spot, limes which had not been cultivated for some years have been cleared of bush, and they appear to be in good condition and but little troubled by scales, although the red, purple and white scales are all present. In another case also limes which have been recently cleared of bush are in much better

condition than others which have been cultivated and kept free from bush. This accords with experience in other places where it has been found that neglected, overgrown limes are generally free from scales, even though grown in the near vicinity of badly attacked, unhealthy trees. In one instance many of the young trees had recently been overgrown by rapidly growing weeds, such as *Ipomoea umbellata*, a white-flowered butterfly pea (*Clitoria sp.*) and another leguminous vine called wina (*Teramnus sp.*). I was informed that such trees had no scales when the vines were first removed.

At the base of a number of trees, nests of ants, the stinging ant or fire ant (*Solenopsis geminata*) and a carpenter ant (*Camponotus sp.*), were to be seen. In order to find if the presence of ants had any relation to the infestation, I made notes on this point; but it would appear that in this instance ants had no influence on the presence of this species of scale-insect.

Wherever red scale was abundant in Antigua there were two ladybird beetles in numbers; one of these was the red ladybird (*Cycloneda sanguinea*) and the other a minute black or bluish black species, not larger than a pin's head.

During this visit every opportunity was taken to examine cotton for any signs of the presence of the flower bud maggot, but no such indications were seen; though this pest has since been reported by Mr. Jackson as being found on the 29th December.

In two plantations boll-worm was present and in one instance had done a considerable amount of damage. At this place cotton and corn were planted together, and it is likely that the corn has provided breeding places for a large number of boll-worms which had gone from the corn to attack the cotton. This transference may take place either by the larvae leaving the corn plant and going over to the cotton, or the larvae may attain their full growth in the corn, the moths of the following generation depositing their eggs on the cotton. I advised that the corn should be removed at once and all the stalks fed to the stock, such ears as were ripe enough being kept for grain. I also recommended that children should be sent into the cotton to collect all injured bolls, which should be destroyed by being turned into the cattle pens. It was further suggested that by planting corn through the field at once it might provide an attractive place for egg-laying when the moths from the worms which escaped the other methods of collection should mature; but if this were done it would of course be necessary to cut the corn and feed it out before any worms which might attack it should have an opportunity of becoming full fed.

In the second plantation boll-worms were less numerous, but they had done an amount of damage. The attack here was mainly on the younger bolls and on the buds, and the larvae apparently wandered from one bud or boll to another and having eaten out the interior moved on again. Several of these worms were observed, generally attacking bolls which were so small that the caterpillar could not get entirely inside them. The presence of a small amount of Guinea corn in these fields of cotton probably accounted to a large extent, at least, for the presence of the boll-worm.

At Skerretts' Experiment Station a number of interesting things were observed. Cassava was attacked by the cassava worm, the larva of the common Sphingid moth (*Dilophonota ello*). These larvae were of two kinds, green and

purple. In a recent letter Mr. Tempany gives an account of rearing the adults from these larvae. He separated them into two lots and found that the green larvae remained green and the purple larvae remained purple until fully grown. The larvae of both colours pupate in exactly the same manner, and when the adults emerge the moths from the two lots of caterpillars are alike.

A small plot of castor, which was being grown for experiment in Eri silk culture, was found to be attacked by considerable numbers of a leafhopper, while both the cassava and castor were attacked by a lace bug (*Corythuca sp.*).

The sweet potatoes at Skerretts were attacked by the larvae of a butterfly (*Junonia sp.*).* This is a delicate and spiny caterpillar about 2 inches in length, and was fairly abundant throughout these plots. The occurrence of this butterfly larva as a pest on sweet potatoes is very unusual, at least I have never observed it before. The ordinary potato worm, *Herse* (*Protoparce*) *cingulata*, occurs as a pest of sweet potatoes in Antigua, but I saw no instance of it during this visit. A small green caterpillar was present feeding on the potatoes in the plots, but I was not able to obtain the adult.

The cow-peas at Skerretts were attacked by a boring larva in exactly the same manner as those found by me in Barbados in 1911 from which a new species of moth was reared. The attack on Canavalia, which I reported having observed in St. Kitts in the early part of 1912, was also similar in nature to this. I was very interested to observe the large numbers of a predaceous bug which occurred in these cow-peas at Skerretts. This insect (*Zelus rubidus*) has often been reported in different places in the West Indies, but I have never before seen it in such numbers. I am of opinion that it was present because of the large number of the larvae of the cow-pea or woolly pyrol moth (*Thermesia gemmatalis*). These larvae were causing a certain amount of injury to the cow-peas and the predaceous bug was present on all the plants.

* [Probably *Precis lavinia zonalis*, Feld., the only species of the genus known as yet from Antigua. The larvae of another Nymphalid butterfly (*Acraea terpsichore*, L.) have been recorded by Mr. C. C. Gowdey as damaging sweet potatoes in Uganda.—Ed.]

Lime trees in Antigua, showing branches broken by the attacks of the Lime Twig Borer *(Elaphidion mite*, Newm.).

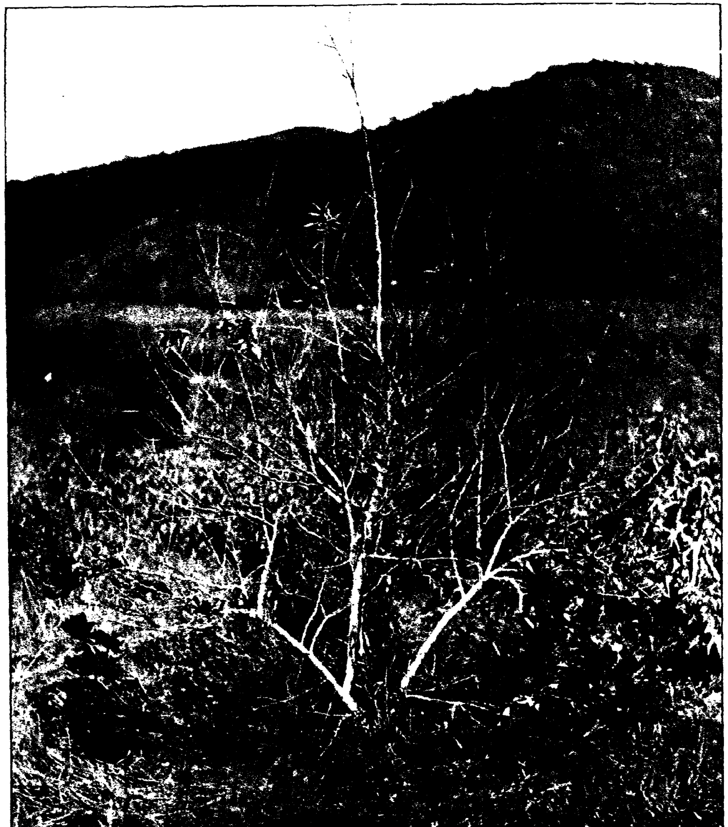


Fig. 1. Young lime tree nearly killed by the attacks of California Red Scale (*Chrysomphalus aurantii*).

Fig. 2. A healthy young lime tree.

NOTES ON SCALE-INSECTS (COCCIDAE).—PART I.

By Professor R. Newstead, J.P., F.R.S.,

The Liverpool School of Tropical Medicine.

During the past few months a large amount of Coccid material has been submitted to me for identification through the Imperial Bureau of Entomology. A large proportion of the species came from Uganda where they were collected by the Government Entomologist, Mr. C. C. Gowdey; smaller collections were also received from other parts of Africa, including Zanzibar; and from Barbados from Mr. John R. Bovell, Superintendent of Agriculture. Nearly all of the new species which have so far come to hand are described in this paper; and records and descriptions of other species are also given where it has been thought desirable to do so.

Monophlebus raddoni, Westwood.

UGANDA: near Kakindu, Basonga, 23. viii. 11 (*S. A. Neave*).

There were two males from the above-named locality, which agree in all the essential details given by Westwood.* These examples were accompanied by another male Coccid of the same genus, but this is larger, has a brighter costal stripe, and there are also slight differences in the caudal tubercles or "tassels." Possibly this specimen represents a distinct species, but in the absence of females I feel that it would be unwise to erect a new name for it. The example bears the same data as those of *Monophlebus raddoni*, Westw.

Icerya longisetosa, Newstead.

Icerya longisetosa, Newst., Sond. Mitteil. Zool. Mus. Berlin, v, pt. 2, p. 154, fig. 1 a–c (1911).

This Coccid was described from material collected by Professor Vosseler at Amani, German East Africa, in the year 1903, but the waxen covering of the adult female was so badly damaged through being preserved in alcohol that it was impossible to give a description of its formation. Dr. Simpson's specimens are, however, in a much better state of preservation, though not so perfect as one could wish them to be for descriptive purposes. I append below a description of the waxen covering and the ovisac of an old adult female.

Length, 10–14 mm.; width, 9–10 mm.

Dorsum thickly covered with short and more or less rounded plates which have so completely coalesced as to render their true form doubtful; submarginal plates curved and narrowed distally, they average about half the length of marginal ones; the latter very stout, narrowing distally and reaching in some cases a little beyond the ovisac, in others they terminate at or near its distal margin; cephalic plates enormously thick, recurved and sometimes also slightly contorted. Ovisac complete and similar in texture and colour to the secretionary covering and plates of the dorsum.

* Arcana Entom., i, p. 21, pl. vi, fig. 3 (1841).

SIERRA LEONE: Daru, 18. viii. 12 (*Dr. J. J. Simpson*).

The ovisacs contained numerous dead larvae which agree in every detail with typical examples from Amani; the enormous length of the antennae and caudal hairs being strikingly characteristic.

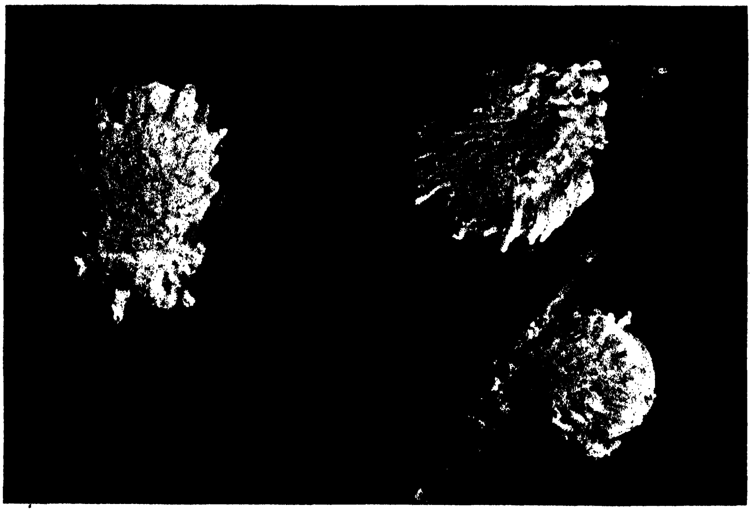


Fig. 1.—*Icerya longisetosa*, Newst.

Icerya purchasi, Maskell.

ZANZIBAR (*Dr. W. M. Aders*).

Found on orange and other species of Citrus. This is a new locality for this destructive pest, which is generally known as the "fluted scale."

Dactylopius (Pseudococcus) obtusus, Newstead.

Dactylopius (Pseudococcus) obtusus, Newst., Sond. Mitteil. Zool. Mus. Berlin, v, pt. 2, p. 164 (1911).

Female, adult (figs. 2 and 3).—Dorsum completely covered with a creamy white and rather closely felted secretion, with some indication of being divided into regular plates; margin with a series of creamy white or pale buff appendages, relatively short at the sides, but lengthening as they approach the posterior margin, where they are of great length, distinctly curved or twisted, and very stout; all the appendages rest more or less upon the ovisac. Ovisac complete, rather closely felted, and firmly attached to the insect. Colour creamy white or buff white, very highly convex, widened posteriorly, narrowed somewhat anteriorly; both longitudinally and transversely striated or faintly fluted, the longitudinal striae being much more distinct and also more widely separated than the transverse ones which are decidedly faint. The size of the ovisac and secretionary covering combined as compared with that of the female is extraordinary.

In my original description of this insect I was unable to give any information regarding the external covering of the female, as all the cereous matter had been

dissolved by the alcohol in which they were preserved. I now find that the covering and ovisac together give the insect a very striking resemblance to a species of *Icerya*, so much so that it might easily pass as such without an examination of the structural characters. Maskell* describes a similar insect (*Dactylopius iceryoides*), but this species is in many ways quite distinct from *D. obtusus*.

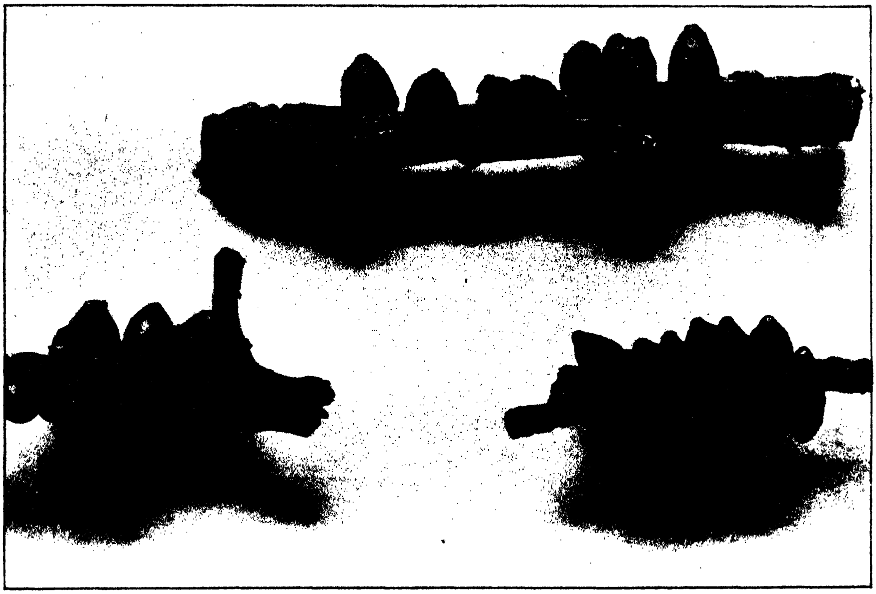


Fig. 2.—*Dactylopius obtusus*, Newst.

GERMAN EAST AFRICA: Dar-es-Salaam and Tanga, vi. 1911 (*Prof. R. Newstead*); ZANZIBAR: Kiungani, 1912 (*Dr. W. M. Aders*).

Dr. Aders' examples were found on the leaves and fruit pedicels of the mango. The pedicels submitted were completely covered on one side with the Coccids.

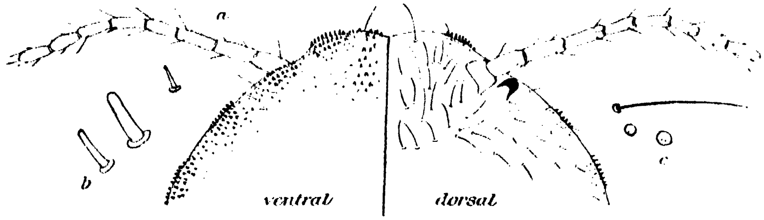


Fig. 3.—*Dactylopius obtusus*, Newst., cephalic portion of adult female; *a*, antenna; *b*, spines; *c*, spinnerets and hair.

When passing through Dar-es-Salaam and Tanga, in June 1911, I found this insect swarming on two unidentified shrubs, which were under cultivation in both

* Trans. New Zealand Inst. xxv, p. 33 (separata), pl. vii, figs. 1–5 1891).

the above-named places. It is evident therefore that this species has a wide distribution on the East Coast of Africa; and judging by its enormous numbers it must cause serious injury to the plants which it infests.

Stictococcus gowdeyi, sp. n.

Female, adult (fig. 4).—Hemispherical, with a deep subcentral transverse depression in front of the anal orifice.* Integument smooth and so brilliantly polished as to appear almost glass-like. Colour rich dark castaneous to piceous. Margin with a narrow fringe of closely set, pale orange-yellow spines; and there is a narrow vertical band of white secretion over the anterior stigmatic clefts.

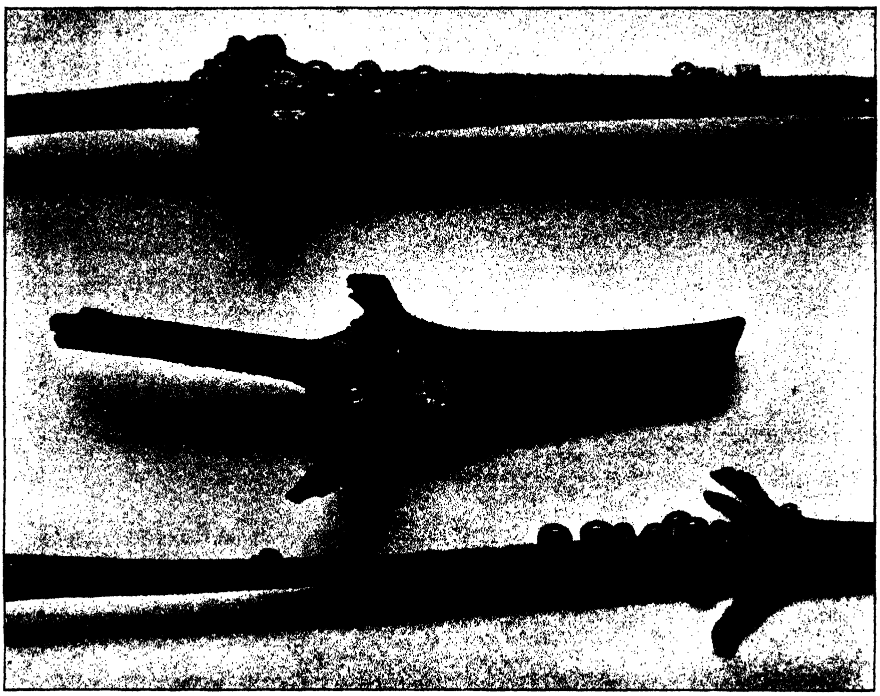


Fig. 4.—*Stictococcus gowdeyi*, Newst.

Ventral surface of fringe covered with white secretion. Antennae short, and of five segments; distal segments with several stiff spinose hairs. Legs well developed; tarsus decidedly shorter than the tibia; upper digitules long, normal; lower digitules so broadly dilated as to appear almost fan-shaped. Anal orifice normal; but surrounded by an unusual number of long hairs. Margin of body with a thickly set fringe of long stiff spines, arranged 3–4 deep, and placed at intervals between them and also slightly above them are some very long slender hairs. *Greatest diameter*, 1·6–2·2 mm.

* This organ is placed "in the middle of the back" (Cockerell) in this genus. R. N.

Larva of female.—Ellipsoidal; anal orifice in the middle of the dorsum, as in the adult female; upper plate with four immensely long, stiff hairs, and the inner edge fringed with minute hairs; lower plate with (?) two long stiff hairs; chitinous ring surrounding the plates, ovoid. Dorsum with four longitudinal rows of long, curved, and laterally serrated spines (fig. 5*a*); marginal spines (fig. 5*b*) similar, but much longer, and almost straight, with the tips more or less pointed; alternating between the long serrated spines are some short ones with slightly dilated and obtusely rounded tips. Immediately in front of each antenna is an immensely long, stiff hair, and there are two hairs at the end of the body which are of greater length. Antennae of six subequal segments, terminal

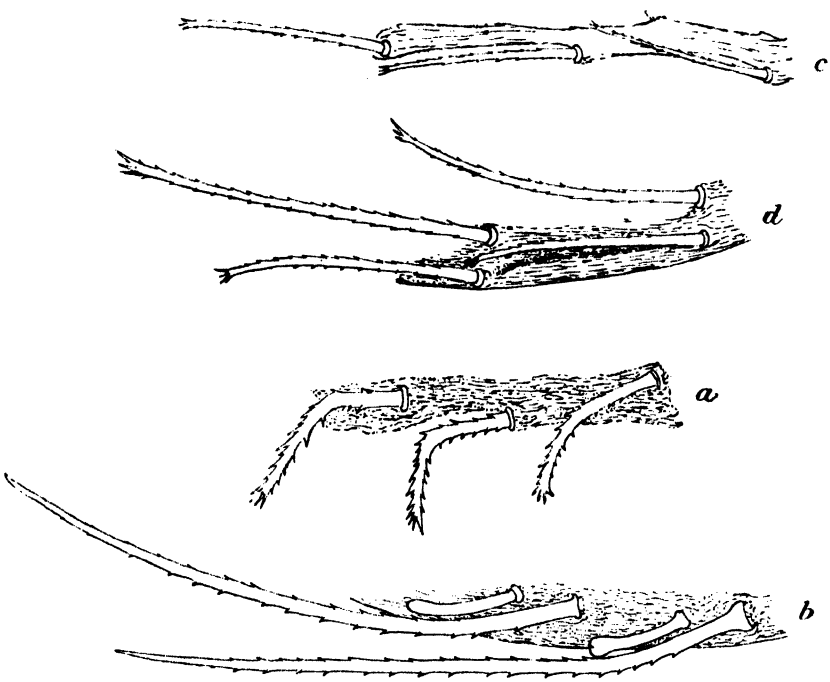


Fig. 5.—*Stictococcus gowdeyi*, Newstead; *a*, dorsal spines of the larva of the female; *b*, marginal spines of the same; *c*, dorsal spines of the larva of the male; *d*, marginal spines of the same. All the figures are drawn to the same magnification.

segment with numerous spinose hairs. Mentum large, bimerous; rostral filaments very long. Legs with a very long stiff bristle-like digit to the tarsus; digitule of the claw as in the female.

Larva of male.—Much more elongated than the larva of the female. Dorsum with four equidistant rows of relatively slender, serrated and almost straight spines (fig. 5*c*); marginal spines (fig. 5*d*) similar, but longer and arranged in pairs; all the spines both marginal and dorsal are much more widely separated than are the corresponding spines in the larva of the other sex. *Buccal organs obsolete.* Anal orifice in the normal position at the distal end of the body. Legs similar to those of the larva of the female. Number of segments in the antennae doubtful.

UGANDA: Entebbe, 10. viii. 11 (*C. C. Gowdey*).

The females were so numerous in some instances as to cover almost completely the stems of the food-plant (*Haranga madagascariensis*), looking somewhat like small glass beads accidently fastened to the branches. It is a very remarkable and highly interesting species, easily distinguished by its hemispherical form, the glass-like texture of the integument and the fringe of immense spines at the margin of the body.

Recently I have discovered that the larvae of *Stictococcus sjoestedti*, Ckll., are dimorphic; so that, including the larvae of *S. dimorphus*, Newst., and those of the insect herein described, there are now three known species of *Stictococcus* having dimorphic larvae, a character which is of the highest interest for the zoologist.

I have the greatest pleasure in dedicating this insect to its discoverer, Mr. C. C. Gowdey, who has done so much towards extending our knowledge of the Coccid fauna of Uganda. In this connection I would urge him to search diligently for the males whose puparia may possibly occur upon the leaves or some other portion of the food-plant some distance away from the females.

Ceroplastes coniformis, sp. n.

Female, test (fig. 6).—Thin and distinctly cone-shaped, with the apex bluntly pointed; not divided into plates, but with a more or less distinct, minute, ovate

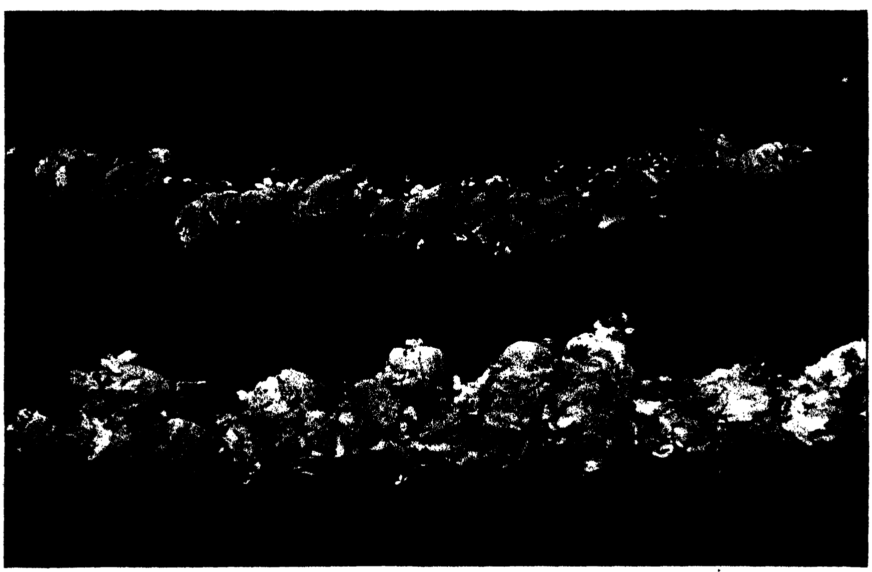


Fig. 6.—*Ceroplastes coniformis*, Newst.

patch of secretion at the apex of the test, and in the more perfect individuals some small white patches of secretion over the stigmatic clefts. Colour translucent yellowish-brown, sometimes with indefinite darker markings due evidently to foreign matter. *Height*, 3·9–4·7 mm.; greatest diameter at base, 2·8–4 mm.

Female, adult.—Form similar to that of the test, but slightly less bluntly pointed dorsally. Integument strongly chitinised, pale yellowish-brown, margins and a small area surrounding the anus dark red-brown. Cephalic area constricted and forming a slight projection in front. Stigmatic clefts small, but very clearly defined and studded with small conical spines; *externally* the spines occupy a relatively small area, and vary slightly in size. Derm with rather large, ovate and translucent pores at the margin, being especially numerous on the cephalic projection; those of the dorsum minute and very widely separated. Caudal process rudimentary and varying from dark castaneous to black or piceous; anal lobes small and widely rounded distally. Antennae (fig. 7*a*) of six segments, the third being equal to or a little longer than the three succeeding segments together; fourth, fifth and sixth each with a stout spinose hair. Legs (fig. 7*b*) with the tarsi as long as the tibiae, the latter distinctly produced ventrally; digitules normal.

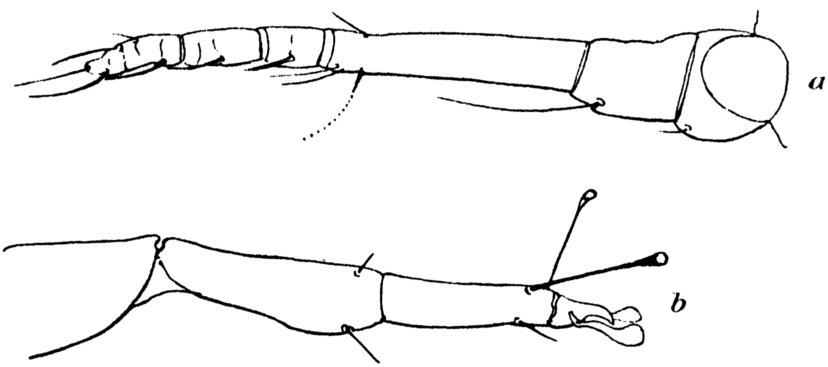


Fig. 7.—*Ceroplastes coniformis*, Newstead: *a*, antenna of adult female: *b*, leg of same.

Measurements very slightly less than those of the thin waxen covering or test.

Female, second stage.—Subcircular in outline; margin with bright yellow, tubercular appendages formed of secretionary matter similar to those in the male puparia; dorsum pale brown (in dead example), with patches of yellow secretion arranged more or less in regular sequence and distinctly separated. The position of the stigmatic clefts is indicated by a single long stout seta-like process which projects considerably beyond the margin.

Male puparium.—Rather narrowly elongate, extremities equally rounded; margin with a series of well-marked tubercular projections, each tubercle furnished at the tip with a few stiff spine-like processes; dorsum not divided into plates, but covered with flake-like patches of secretion. Colour bright pale yellow; texture glass-like.

UGANDA: Entebbe, 16. xi. 12 (*C. C. Gowdey*).

Taken on *Ficus* sp. in the Botanic Gardens.

This is a markedly distinct species of *Ceroplastes*, easily recognised by the unique cone-like form of the female and its test or waxen covering.

Ceroplastes africanus, Green.

NORTHERN NIGERIA: Kogin Sirikin Pawa, xi. 1910 (*J. J. Simpson*).

In none of the four examples before me is there any sign of the nipple-like prominence noted by Green,* neither is there any trace of lateral waxen plates. In its external characters therefore, it agrees best with *Ceroplastes egbarum*, Cockerell;† but this species has, according to its author, "no lateral humps," whereas the examples taken by Dr. J. J. Simpson have well-marked thoracic and sub-anal humps or tubercles; clearly therefore they cannot be referable to *C. egbarum*; and although Green makes no reference to the presence of these organs in *C. africanus*, yet he figures them (*loc. cit.* fig. 1*b*) as being present in the young adult female. Unfortunately I was unable to dissect out the antennae, so that I cannot say if these organs agree with those of typical *C. africanus*. All that I can add regarding these structures is that the first to the fourth segments agree with the corresponding segments noted and figured by Green (*loc. cit.* fig. 1*f*). One other discrepancy that I have noted in Simpson's specimens is that the stigmatic spines at the extreme margin are simple, stout and rather long, not "small conical ones" as noted by Green; but inside these longer spines are innumerable minute conical ones occupying a large area which in form and extent is almost identical with the stigmatic area in *C. ugandae*, Newst.‡

Possibly the Nigerian examples may prove eventually to be a well-marked race of *C. africanus*, but much more material is needed before one can definitely decide upon this question.

Ceroplastes ugandae, Newstead.

UGANDA: Entebbe, 12. viii. 11 (*C. C. Gowdey*).

Found on *Anona muricata*.

The organs described and figured by me in this Bulletin (vol. ii, p. 94, fig. 8*c*) as "parastigmatic glands" are undoubtedly clear spaces in the dense chitin to which extremely minute spines are attached. I should point out also that this Coccid presents several characters in common with *Ceroplastes fulleri*, Ckll.,§ but in the description of the latter Cockerell makes no reference as to the presence of tubercles on either side of the caudal process or to those which occur over the stigmatic clefts; neither does he mention the papillae which render the integument so strikingly characteristic in *C. ugandae*.

Lecanium (Eulecanium) filamentosum, sp. n.

Female (? adult), dried examples.—Orange brown, integument shining. Form oblong-oval, narrowed anteriorly and with one side generally more distinctly curved than the other; median area slightly raised, marginal zone very broadly flattened and translucent; *margin with a distinct fringe* of rather widely separated, short, glass-like filaments, all of which are attached to the tips of the truncated

---

* Ann. Mag. Nat. Hist., (7) iv, p. 188, figs. 1–1 *f* (1899).

† Entomologist, xxxii, p. 127 (1899).

‡ Bull. Ent. Research, ii, p. 94, fig. 8*c* (1911).

§ Entomologist, xxxv, p. 113 (1902).

marginal spines. Dorsum rather strongly wrinkled, and with a well formed ridge over the stigmatic areas. Integument rather closely studded with tubular glands or spinnerets (fig. 8*a*), the orifices of which are circular or cup-shaped ; besides these there are numerous well defined compound groups of spinnerets (fig. 8*b*), but in these the subcutaneous tubes are very short and suddenly attenuated, so that the whole structure appears like a truncated pear in miniature. Marginal spines (fig. 8*c*) stout, suddenly truncated, the truncated ends being in many instances divided so that they present either a deep cleft or a more or less

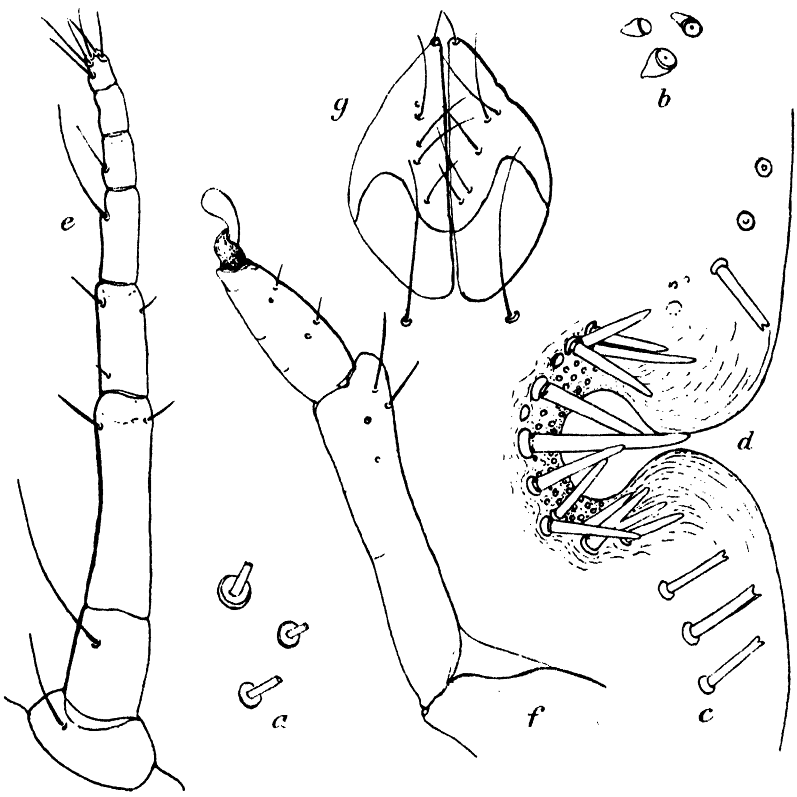


Fig. 8.—*Lecanium filamentosum*, Newstead, female : *a*, dorsal glands ; *b*, compound spinnerets : *c*, marginal spines : *d*, stigmatic cleft : *e*, antenna ; *f*, tibia and tarsus ; *g*, anal lobe.

jagged appearance. Stigmatic clefts (fig. 8*d*) strongly evaginated and thickly set with a series of stout spines varying in number from 9–13 ; between these and the extreme margin is a group of circular spinnerets. Antennae (fig. 8*e*) of eight segments, of which the third is much the longest, being almost equal in length to the last four segments together : the fifth is also unusually long. Legs stout ; tarsi (fig. 8*f*) very short ; lower digitules broad and spathuliform ; claws very short. Anal lobes (fig. 8*g*) with four or five long hairs ventrally and two or three distally. *Length*, 4–6·2 mm. (older examples may be much larger).

Puparium of the male.—Glassy opaque white; the three bilateral transverse ridges and also the anal cleft strongly pronounced; *dorsum with a very deep median transverse cleft*, arising from which, on the posterior surface, is a relatively large rectangular process of yellowish or creamy-white secretion; the median oblong cell or "coronet" on either side of the central cleft closely packed with vesicular processes which, being darker in colour than the surrounding secretionary matter, stand out in marked contrast to the rest. *Length*, 2·7 mm.

Male (dried example) with one pair of white caudal appendages. Abdomen, legs and antennae pale brown; thoracic apodemes piceous; wings with the costa dull crimson. When placed in cold potash the body changes to bright pale crimson, so that it is highly probable that in life the insect is of this colour. Ocelli eight in number, of which four are ventral. Legs and antennae normal. *Length*, inclusive of the anal filaments, 3 mm.; wing, 1·7 mm.

UGANDA: Tero Forest, 13. vii. 12 (*C. C. Gowdey*).

"On an unknown shrub in the depth of forest."

All the females are apparently young adults and it is highly probable that when older examples are discovered they will be found to be much larger; but it is very improbable that they will differ in structural details from the young adults. Like the female of *Lecanium* (*Eulecanium*) *ciliatum*, Douglas, this insect also possesses a fringe of fine glassy filaments; but it is markedly distinct from this or any allied species and may, apart from the marginal fringe, be determined by the form of the marginal spines, the antennae and the well defined groups of spinnerets on the dorsum. The puparium of the male is also strikingly characteristic and quite unlike that of any other species with which I am acquainted.

Lecanium (Eulecanium) somereni, Newstead.

Lecanium mori var. *somereni*, Newst., Bull. Ent. Research, i, p. 187 (1910).

Lecanium (*Eulecanium*) *tremae*, Newst., Sond. Mitteil. Zool. Mus. Berlin, v, pt. 2, p. 162, fig. 5 (1911).

Having examined a fresh series of preparations of the *Lecanium* to which I gave the specific name *tremae*, I have come to the conclusion that this insect is synonymous with *L. somereni*, Newst. Furthermore there can, I think, be little doubt that *L. somereni* is distinct from *L. mori*, Signoret, and must take specific rank.

Lecanium (Saissetia) oleae (Bernard).

UGANDA: Entebbe, 26. viii. 11 (*C. C. Gowdey*).

Found on the hard wood of an unnamed tree.

All the examples are abnormally swollen by the attacks of Chalcidid parasites.

Lecanium (Saissetia) nigrum, Nietner.

UGANDA: Entebbe, 15. viii. 11 (*C. C. Gowdey*).

The leaves of the food-plant (*Anona muricata*) were very heavily infested with females in all stages of development.

Pulvinaria sp. n.

UGANDA: Entebbe, 26. vii. 11. (*C. C. Gowdey*).

Among the many species of COCCIDAE collected by Mr. Gowdey in Uganda is an enormous specimen of a female *Pulvinaria*, measuring, in its dried and shrivelled condition, half an inch in length. This insect had secreted part of its ovisac during transit so that there can be no doubt as to its generic position. Without this evidence one might reasonably have placed it in the genus *Lecanium* and have recorded it provisionally as a young form of *L. sallei*, Sign. The *Pulvinaria* is undoubtedly an undescribed species, but it is inadvisable to describe it until more material comes to hand.

Aspidiotus gowdeyi, sp. n.

Puparium of female.—Very small, obconical and suddenly truncate at the margin of the larval pellicle; margin circular. Colour dark brown, outer margin paler, upper margin orange-brown to pale castaneous. Larval pellicle completely hidden beneath a glistening white secretion, which is perfectly flat, quite circular in outline, and not raised above the upper truncate margin of the secretionary covering of the puparium. Ventral pellicle thin. *Diameter*, 0·4–0·5 mm.

Female, adult.—Broadly ovate, narrowed posteriorly; integument very thin and transparent; presence of rudimentary antennae and parastigmatic glands

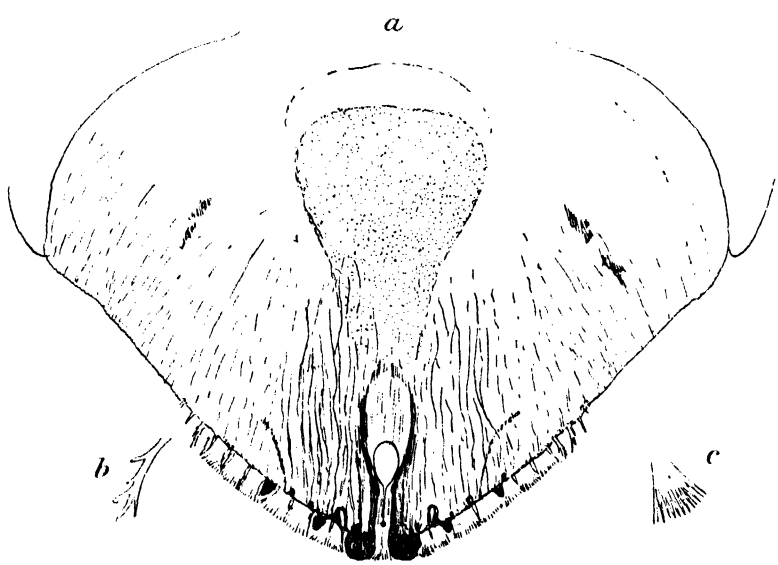


Fig. 9.—*Aspidiotus gowdeyi*, Newstead; *a*, pygidium; *b* and *c*, squamae.

doubtful. Pygidium (fig. 9*a*) with six lobes; median lobes much the largest, distal margin broadly rounded; second and third pair small and somewhat triangular, with the distal margins more or less pointed. Squamae very finely and closely fringed; those between the median and third pair of lobes and the three succeeding ones, on either side, unusually broad (fig. 9*c*), the two proximal ones (fig. 9*b*) small and branched. Only two spines are traceable and these are placed

on opposite sides beyond the squamae. There is a very small bilateral incision near the second pair of lobes and a rather long thickening of the integument near each of the third lobes. Anal orifice large and submarginal. Position of the vaginal orifice rendered obscure by a large and somewhat tongue-shaped thickening of the integument occupying the middle area of the pygidium. Circumgenital glands absent.

UGANDA: Entebbe, 13. viii. 11 (*C. C. Gowdey*).

Found on *Anona muricata*.

This small species of *Aspidiotus* possesses three well-marked characteristics; the curiously truncated puparium of the female, with its flat white central spot, formed by the larval secretion; the broad and finely fringed squames; and the large tongue-shaped chitinous patch in the centre of the pygidium.

Gymnaspis africana, sp. n.

Puparium of adult female.—Nude, with the exception of a small central area which is covered with the larval pellicle; ventral pellicle very thin, circular in

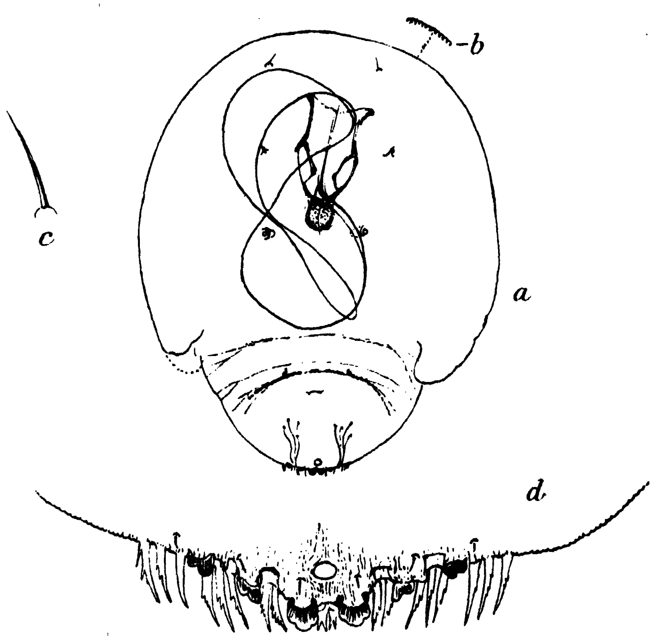


Fig. 10.—*Gymnaspis africana*, Newstead; *a*, adult female; *b*, crenulated margin; *c*, rudimentary antenna; *d*, fringe of pygidium.

outline, about one-fourth the diameter of the puparium and occupying a central position. In form it is highly convex and attenuated posteriorly. *Length*, 0·9–1 mm.

Female, adult (fig. 10*a*).—Broadly ovate, the (?) first abdominal segment forming a distinct lobe-like extension. Pygidium broadly rounded; margin of pygidium (fig. 10*d*) with three pairs of lobes; median pair more or less trilobed,

second pair with a deep lateral notch, third pair similar but smaller and with the projecting lobe more or less angular. Squames narrow and divided laterally, but scarcely fimbriated, one or two of the proximal ones being spiniform. Rudimentary antennae furnished with a single and unusually long hair (fig. 10*c*). Parastigmatic glands absent. Rostral filaments of great length in the young adult, being, approximately, twice the length of the body. Sexual orifice proximal. Anal orifice sub-marginal.

UGANDA: Tero Forest, 13. vii. 12 (*C. C. Gowdey*).

"On an unknown shrub in depth of forest," in association with *Lecanium* (*Eulecanium*) *filamentosum*, Newst. The puparia ("scales") were either attached to the edges of the leaves or near the edge of an artificial perforation.

The puparium of this Coccid is distinguishable by its dull crimson colour; the female by the lobe-like extension of the abdominal segment and the great length of the hair on the rudimentary antennae.

Described from two adult females and five puparia.

Chionaspis unilateralis, sp. n.

Puparium of adult female.—White and translucent; very long and narrow, sides parallel but not perceptibly flattened. Larval pellicle pale yellow; margin without spines; second pellicle ochraceous or faintly darker than the rest of the puparium. Ventral scale represented by a narrow strip attached to the margins of the puparium. *Length*, 2·4–2·75 mm.

Male puparium.—White, distinctly tricarinate; larval pellicle yellow, often with a patch of dark colour centrally.

Female, young adult (fig. 11*a*).—Elongate, with four of the abdominal segments, *on the left side of the body only* (fig. 11*b*), very distinctly tuberculate; of these the second, third and fourth each bear a single huge spine-like squama; in addition to the latter the lobes are also provided with tubular glands, the third tubercle having a well-marked transverse series of seven or eight (fig. 11*c*) on the dorsal surface. Pygidium (fig. 11*d*) with three pair of lobes, the median pair being partly recessed and the free edge finely serrated; second pair of lobes simple and projecting beyond the first; third pair narrowly separated from the second. Marginal, cylindrical spinnerets large; there are usually eight on either side of the median lobes. Circumgenital glands in five groups; the formula of five examples is given below:—

1	2	0	2	2
6—6	5—5	5—5	5—6	6—6
8—8	7—8	7—8	5—7	8—8

Rudimentary antennae (fig. 11*e*) each with a very long curved spinose hair. Parastigmatic glands absent; but there is a series of short tubular spinnerets extending from the lower right stigmen, these organs being entirely absent from the stigmen on the opposite side.

Female, old adult.—Much more elongate than the preceding and with normally short rostral filaments. In all the other morphological details it does not differ from the young adult,

BARBADOS: Merton Lodge, 22. i. 13 (*H. B. Bannister*).
On leaves of a palm (*Thrimax* ?); forwarded by Mr. John R. Bovell, Superintendent of Agriculture.

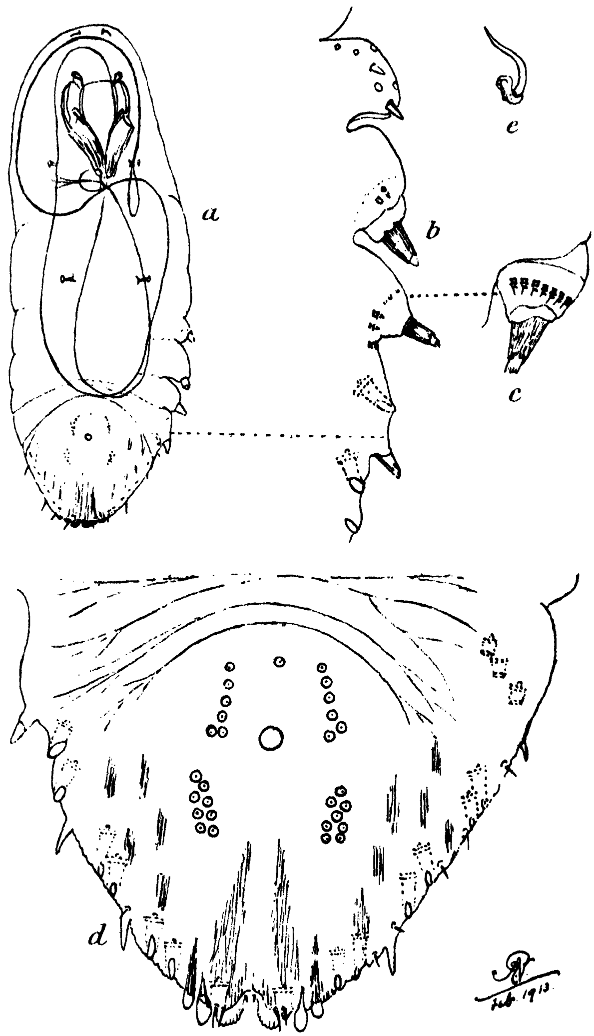


Fig. 11.—*Chionaspis unilateralis*, Newstead; *a*, young adult female after maceration in potash; *b*, left marginal tubercles; *c*, one of the tubercles enlarged showing spinnerets, &c.; *d*, pygidium; *e*, rudimentary antenna.

Though the puparium of the female is very strikingly like that of *Chionaspis elongata*, Green,* the female of *C. unilateralis* is clearly distinct and easily recognisable by the extraordinary asymetrical arrangement of the large squama-bearing lobes on the abdominal segments.

---

* Coccidae of Ceylon, p. 125, pl. xxxix, figs. 1-14 (1899).

Leucaspis riccae, Targioni-Tozzetti.

EGYPT: Cairo, 26. xii. 12 (*Lewis H. Gough*).

The specimens are from cultivated olive, which seems to be the principal food-plant of this insect. It is certainly an injurious species, and has been recorded from France, Italy, Greece and Cyprus, but not hitherto from Egypt.

Mytilaspis (Lepidosaphes) beckii (Newman).

ZANZIBAR, 27. x. 12 (*Dr. W. M. Aders*), on orange.

This pest of the orange is known better under its old name *Mytilaspis citricola*, Packard.

ON THE BIONOMICS OF THE SANDFLIES (PHLEBOTOMUS) OF TOKAR, ANGLO-EGYPTIAN SUDAN.

By Harold H. King, F.E.S.

Wellcome Tropical Research Laboratories, Khartoum; Government Entomologist, Anglo-Egyptian Sudan.

The following observations were made during eighteen days spent at Tokar in October and November, 1912. Only a limited amount of time could be given to the work of searching for the breeding places of sandflies, but it is thought that possibly these very brief notes may be of some interest to those engaged in similar research elsewhere.

The town of Tokar is situated about eighteen miles from the port of Trinkitat on the Red Sea and some fifty-eight miles south-east of Suakin. It is the centre of a cotton-growing area comprising between 30,000 and 40,000 acres watered by the flood-river (or khor) Baraka. This khor comes down in flood during the months of July and August and spreads over the plain. As soon as the land is dry enough it is cleaned and almost the whole of it sown to cotton. A few heavy rainstorms usually occur during the months of October, November and December, and cotton picking extends from the latter month till May. The soil is alluvial, and on drying cracks vertically to a depth of several feet, and also horizontally, forming shale-like plates of varying thicknesses. There are scarcely any trees and only a moderate number of low bushes.

This cultivated area is notorious throughout the Sudan for the number and bloodthirstiness of its sandflies. The adults can be found in numbers at distances of at least two miles from any mud or brick wall or building. They are equally numerous on clean land growing cotton and on land on which cotton has failed and which therefore supports only a few grasses and other weeds. The general opinion of the officials who know the district well is that they are confined to the flooded area and that they are not met with in the surrounding desert. Natives who live in the town told me that there they were not troubled by them, but if one spent a night in the cultivations one would meet with plenty. The land on which the town is built is not flooded, being protected by a low embankment of soil.

The main difference between the flooded and unflooded land is the presence of deep cracks, referred to above, which appear in the former as soon as it begins to dry out. Newstead* states that all the sandfly larvae and pupae taken by Marett and himself in Malta were found living under similar conditions as regards (*a*) presence of organic matter, (*b*) presence of moisture, but not in excess, and (*c*) absence of light. The only situations where these three conditions could be found together at Tokar were in the soil itself, and on flooded land the cracks provided the sandfly with an easy means of access to such situations. If these cracks and the soil adjoining them were the breeding places of the Tokar sandflies, the reason why the adults were only found on flooded areas would be explained, and I could think of no other theory which would account for it. All the very limited amount of time which could be spared for this work was spent therefore in searching for larvae and pupae in the soil.

* Annals of Tropical Medicine and Parasitology, v, no. 2, August 1911, p. 141.

The spot chosen for the purpose was a plot of well-cleaned land under cotton, distant $1\frac{3}{4}$ miles from the nearest mud or brick building or wall. Here adult sandflies existed in myriads. Numbers could be found by turning over clods of earth, as many as fifteen—approximately—sometimes being seen under a single clod. Vertical cracks extended to a depth of from three to four feet, so holes were dug to this depth and the soil at the sides, especially that in the neighbourhood of cracks, carefully picked to pieces and searched. A single larva, which I believe to belong to a species of *Phlebotomus*, was obtained. This larva, which corresponds almost exactly with Newstead's figure and description of the second instar of the larva of *P. papatasii*, is described below. It was found at a depth of about four inches, in damp earth, in the vicinity of a crack, and when alive, closely resembled the soil in colour. Moreover when first exposed it did not move and so might easily have been overlooked. When placed on a flat surface it made no attempt to flick itself away but merely crawled slowly along by means of its prolegs. It was killed and preserved as the chances of my being able to rear the adult from it were, under the circumstances, infinitesimal.

Although I could find only this one specimen I believe that there were numbers in the soil. With a tropical sun shining on one's back, numbers of house-flies tickling one's face, and a gale of wind blowing dust into one's eyes and the particles of soil from under one's hand, it is not difficult to overlook such an inconspicuous object as a sandfly larva or pupa. Lumps of soil were taken to the house and examined there but these yielded nothing.

A species of wagtail (*Motacilla alba*) was frequently observed catching adult sandflies at dawn, before they had taken shelter for the day.

My thanks are due to Mr. G. G. Macdonald, Agricultural Inspector at Tokar, for very kindly giving me every assistance in his power.

Description of Phlebotomus larva.

Length: 3 mm. Colour: general appearance when alive, dark brown; after death, head dark brown, mandibles, labial plate and dorsal process on anal segment black, hairy spines yellowish-brown, thorax and abdomen yellowish-white.

The first joint of the antenna is small, the second and third are broad, flat and rounded in outline, the latter terminating in a short bristle. The thoracic segments have the rows of hairy spines continued on the ventral surfaces, forming complete rings. A similar ring is situated on the space between the head and the first thoracic segment, the ventral spines of this ring—four in number—being long and pointed instead of comparatively short and clubbed. The hairy spines on the thorax and abdomen are shorter and more noticeably clubbed near the head, and become longer and less clubbed towards the anal end. The transparent tips of these hairy spines are less swollen than are those of *P. papatasii*. On the basal half of the dorsum of the anal segment is situated a black process, roughly rectangular in outline with a finely serrated margin. From the top of this process arise two smaller processes, each bearing two of the four caudal bristles and also two hairy spines, similar to those on the abdominal segments. There is a dark area on the dorsum of the penultimate segment.

So far as I can judge from Newstead's figure and description, this larva resembles that of *P. papatasii* in its second instar in all other details.

NOTE ON AN ENTOMOLOGICAL STORE-BOX SUITABLE FOR USE IN THE TROPICS.

By Harold H. King, F.E.S.,
Government Entomologist, Anglo-Egyptian Sudan.

The following is a description of a modified and improved form of the store-box described by Mr. H. Maxwell-Lefroy in Parasitology, vol. iv, p. 174 :—

In Khartoum, where the shade temperature is sometimes 116° F., boxes of the type in use at Pusa were found to be unsuitable. The tops and bottoms of many of them split, while the paraffin wax became too soft to hold the cork carpet in position. The type of box which I am now using and which is proving very reliable, differs from the Pusa box in two respects. Instead of being made entirely of teak, the top and bottom are of three-ply wood, and the cork carpet instead of being bedded in paraffin wax is held in position by glue. In all other respects it resembles the Pusa box, the cork carpet being enamelled white above and covered with a mixture of 80 per cent. paraffin wax (melting point 136° F.) and 20 per cent. naphthaline, melted and run in when the glue has become firm.

ON A NEW SPECIES OF MYMARIDAE FROM TRINIDAD.

By Charles O. Waterhouse, I.S.O.

Anagrus flaveolus, Waterhouse, sp. n. (fig. 1).

Clear pale lemon yellow. The antenna with the 4th to 9th joints very pale grey. Third joint very small, a little longer than broad, about half the length of the second joint. Fourth joint rather slender, the length of the 2nd and 3rd taken together. The fifth about one-quarter shorter, about the same width. The 6th, 7th and 8th subequal, about the same length as the 5th but rather broader. Wings hyaline, with a very slight shadow below the vein, very nearly nine times as long as the greatest width (·525 × ·06 mm., approximately). Marginal cilia moderately strong, the longest ·132 mm. There is a line of hairs running along the middle of the wing from the apex of the vein to near the

Fig. 1.—*Anagrus flaveolus*, Waterh.

apex of the wing; between this and the front margin there is another line of about twelve hairs, rather irregular, and there are a few hairs irregularly placed in the apical area. Between the central line and the hind margin there is an irregular line of about eight hairs, but they are not the same on both wings. Hind wings free from surface hairs, except three or four at the extreme apex. The posterior cilia moderately stout, except the first three or four, the longest about ·1 mm.

The specimens were in spirit, but appear to have retained their natural colour. The figure is from one of the specimens mounted in balsam by myself and micro-photographed by Mr. Enock.

The insects were forwarded to the Imperial Bureau of Entomology by Mr. P. Lechmere Guppy, Assistant Entomologist to the Board of Agriculture, Trinidad, who bred them from eggs of the corn leaf-hopper, *Peregrinus* (*Delphax*) *maidis*.

[Dr. R. C. L. Perkins, who has examined this insect, informs us that it is extremely closely allied to *Anagrus frequens*, Perkins, originally described from

Hawaii, and *A. columbi*, Perkins, from Columbus, Ohio, being intermediate between them. The three forms agree in their general shape and colour, and in the structure of the antennae, the only distinctions consisting in the distribution of the discal hairs on the forewing. It is possible that the three forms may prove to be merely local races of a single species. *A. frequens* appears to have a wide range, and according to Dr. Perkins, it attacks four different genera of leaf-hoppers in Hawaii, including *Peregrinus maidis*.—Ed.]

ON TWO VARIETIES OF GLOSSINA MORSITANS FROM NYASALAND.

By Dr. J. O. Shircore.

Medical Officer, Sleeping Sickness Investigations, Nyasaland Protectorate.

Glossina morsitans, Westw., var. **pallida,** nov.

Thorax slate-grey, pattern indistinguishable; scutellum with two dark triangular areas which are contiguous at their upper inner angles. *Abdomen* with the darker blotches on each side of the second segment very faint; on the other segments the banding is not a prominent feature, as it is in the typical form; the bands olive-grey, their margins being distinct and defined from the ground-colour, which is a few shades lighter. In the middle line the banding is cut off square, leaving a very narrow straight line down the centre of the segments; the outer margins of the bands sloping away from below upwards and leaving light areas on each side. *Legs* with all the joints of the front and middle tarsi pale, except the distal end of the latter which has a faint darkish ring; the last two joints of the hind tarsi faintly dark, but nothing like so dark as in *G. morsitans*. *Wings* tinged with light yellowish-brown.

Nyasaland: 1 ♂, Dowa district, 6. v. 1912.

Type in the British Museum.

This fly was picked out at a glance from more than a hundred *G. morsitans*, and is distinctly and remarkably paler throughout.

Glossina morsitans, Westw., var. **paradoxa,** nov.

Superficially resembles *G. morsitans* in appearance and size, but *the hind tarsi are entirely dark*, as in the *palpalis* group. The superior claspers of the male genitalia resemble those of *G. submorsitans*, as figured by Prof. Newstead, but are more deeply pigmented throughout, and especially along the lateral and posterior borders.

Nyasaland: 1 ♂, Nyamsato, near Chunzi, Dowa district, 4. vi. 12.

Type in the British Museum.

If casually observed, this tsetse would probably be taken for an ordinary *G. morsitans*; but if the abdomen had become discoloured it might well be mistaken for *G. palpalis*. The superior claspers have only been looked at with a hand-lens (× 12); they were prized open and examined *in situ*.

[There is in the British Museum a single male which agrees entirely with the specimen described above as var. *pallida*. Mr. E. E. Austen has made a preparation of the genitalia, and they are certainly indistinguishable from those of typical *G. morsitans*. This specimen was taken by Dr. M. Sanderson on the Chitala stream, Dowa district, 12. xi. 1910.—Ed.]

COLLECTIONS RECEIVED.

THE thanks of the Imperial Bureau of Entomology are due to the following gentlemen, who have kindly presented collections of insects (received between 1st October and 31st December, 1912):—

Dr. W. M. ADERS:—23 *Tabanus*, 13 *Lyperosia*, 4 Hippoboscidae, 17 Coleoptera, 16 Hymenoptera, 10 Isoptera, a number of Coccidae, 2 other Rhynchota, and 4 Fish; from Zanzibar.

Mr. T. J. ANDERSON, Government Entomologist:—2 *Culicoides*, 260 Culicidae, 10 Mycetophilidae, and 4 species of Coccidae; from British East Africa.

Capt. C. H. ARMITAGE, C.M.G., D.S.O., Chief Commissioner; 3 Reduviidae; from the Northern Territories, Gold Coast.

Mr. JOHN R. BOVELL, Superintendent of Agriculture:—50 Scoliid Wasps (*Tiphia parallela*); from Barbados.

Dr. CAMPBELL, W.A.M.S.:—11 *Tabanus*, 2 *Hippocentrum*, 9 *Haematopota*, 3 *Glossina palpalis*, and 2 Asilidae; from Tisana, Sierra Leone.

Dr. G. D. H. CARPENTER, Entomologist, Roy. Soc. Sleeping Sickness Comm.:—6 tubes of Chalcididae from Figs; from Uganda.

Mr. E. DAYRELL, District Commissioner:—1 *Rhinomyza stimulans*, 31 *Chrysops silacea*, 23 *Hippocentrum trimaculatum*, 22 *Tabanus*, and 8 *Glossina*; from Ikom District, S. Nigeria.

Mr. G. C. DUDGEON, Director of Agriculture:—48 Moths; from Cairo, Egypt.

Mr. J. H. J. FARQUHAR, Provincial Forest Officer:—1 *Culex tigripes fuscus*, 1 *Rhinomyza stimulans*, 1 *Chrysops dimidiata*, 41 *Glossina*, 4 Lepidoptera, and 1 Arachnid; from Benin City, S. Nigeria.

Dr. MERCIER GAMBLE:—16 Culicidae, 2 *Simulium*, 1 *Haematopota*, and 4 *Tabanus*; from Belgian and Portuguese Congo.

Dr. S. GOODBRAND, W.A.M.S.:—20 *Glossina palpalis*, 77 *G. longipalpis*, and 16 *G. fusca*; from the Gold Coast.

Dr. LEWIS GOUGH, Government Entomologist:—2 Nitidulid beetles off dates, 2 Drosophilid flies off dates, 3 Chalcididae from figs, and 3 Braconidae; from Cairo, Egypt.

Mr. C. C. GOWDEY, Government Entomologist:—292 Diptera, 2,407 Coleoptera, 580 Hymenoptera, 307 Lepidoptera, 25 Lepidopterous larvae, 23 Mallophaga, numerous Coccidae and Aphidae, 1,108 other Rhynchota, 318 Orthoptera, and 2 Arachnida; from Uganda.

Dr. R. W. GRAY, W.A.M.S.:—2 *Chrysops silacea*, 7 *Tabanus*, and 8 *Glossina*; from Southern Nigeria.

Dr. H. HEARSEY, Principal Medical Officer:—2 Trypetid Flies (*Dacus pectoralis*); from Zomba, Nyasaland.

IMPERIAL DEPARTMENT OF AGRICULTURE, West Indies:—46 Curculionidae and 12 Lamellicornia.

Mr. H. L. JONES, Chief Veterinary Officer:—26 Tabanidae and 16 *Glossina*; from Portuguese East Africa.

Mr. W. KENNEDY, Veterinary Officer:—24 Culicidae, 1 *Haematopota*, 21 *Stomoxys*, and 4 *Hippobosca*; from British East Africa.

Mr. T. F. LINNELL, Assistant Engineer:—42 *Glossina*; from Mombasa, British East Africa.

LIVERPOOL SCHOOL OF TROPICAL MEDICINE:—Type of *Phlebotomus antennatus*.

Mr. Ll. LLOYD, Government Entomologist, 4 *Haematopota rubens*, 4 *Tabanus*, 1 *Stomoxys*, and 4 Hippoboscidae; from Northern Rhodesia.

Dr. R. E. McCONNELL, M.O.:—27 Chironomidae, 46 Culicidae, 77 Tabanidae, 1 *Stomoxys*, 38 *Glossina*, 3 *Lyperosia*, 120 other Diptera, 6 Lepidoptera, 1 Hymenopteron, 1 Hemipteron, 1 Orthopteron, a large number of *Ornithodorus moubata*, and 14 other Ticks; from Uganda.

Dr. J. W. SCOTT MACFIE, W.A.M.S.:—7 *Tabanus*, 9 *Haematopota*, 5 *Chrysops*, 964 *Glossina*, 129 other Diptera, 3 Hymenoptera, 24 Lepidoptera, 22 Coleoptera, 3 Planipennia, and 2 Rhynchota; from Northern Nigeria.

Dr. C. H. MARSHALL, M.O.:—9 *Haematopota*, 5 *Tabanus*, 6 *Glossina*, 1 *Stomoxys*, 2 *Hippobosca*, and 14 other Diptera; from Uganda.

Dr. H. B. OWEN, M.O.:—3 *Dorcaloemus compactus*, 2 *Hippocentrum trimaculatum*, 10 *Haematopota*, 16 *Tabanus*, 16 *Glossina*; from Uganda.

Capt. W. S. PATTON, I.M.S.—34 *Tabanus*, 2 *Chrysops*, 34 *Philaematomyia*, 6 *Bdellolarynx*, and 5 *Lyperosia*; from Madras, India.

Dr. J. S. PEARSON, W.A.M.S.:—82 Culicidae (larvae, pupae, and imagines), 16 *Tabanus*, and 6 *Glossina*; from Moyamba, Sierra Leone.

Dr. E. J. POWELL, W.A.M.S.:—1 Culicid, 353 *Tabanus*, 1 *Glossina*, 5 *Stomoxys*, and 7 other Diptera; from Daru, Sierra Leone.

Miss MURIEL ROBERTSON:—34 Rhynchota; from Uganda.

Mr. C. SAUNDERS, Agric. Dept.:—2 *Hippocentrum versicolor*, 9 *Haematopota*, 5 *Tabanus*, and 32 *Glossina*; from the Northern Territories, Gold Coast.

Dr. JAS. J. SIMPSON:—63 Culicidae, several Culicid pupae, 8 *Chrysops*, 9 *Haematopota*, 94 *Tabanus*, 213 *Glossina*, 2 *Lyperosia*, 94 other Diptera, 4 Siphonaptera, 274 Coleoptera, 286 Lepidoptera, 122 Hymenoptera, 3 Trichoptera, 166 Rhynchota, 115 Orthoptera, 95 Odonata, 6 Ticks, and a number of Mallophaga, Mites, and Intestinal Worms; from Sierra Leone: and 9 *Glossina palpalis*; from the Gold Coast.

Mr. F. SPIRE, Provincial Commissioner:—30 *Anopheles funestus*, 8 *Glossina morsitans*, and 15 other Diptera; from Uganda.

Dr. H. SWALE:—4 Diptera, 20 Coleoptera, 2 Ants, 89 Termites, 1 Cimex, 131 other Rhynchota, 2 Fleas, 10 Ticks, 3 other Arachnida, and 1 Crab; from Caia, Zambesi River, Portuguese East Africa.

Mr. F. W. Urich, Entomologist to Board of Agriculture :—3 Syrphidae and 10 Coccinellidae ; from Trinidad.

Dr. C. E. S. Watson, W.A.M.S. :—44 Culicidae, 1 *Phlebotomus*, 1 *Tabanus*, 11 *Glossina*, 12 other Diptera, 2 Coleoptera, 7 Hymenoptera, 1 Orthopteron, and 9 Rhynchota ; from Ashanti and the Northern Territories.

Dr. R. O. White, W.A.M.S. :—28 *Glossina longipalpis*, and 1 Tachinid ; from Weshiang, Gold Coast.

Dr. C. A. Wiggins, Deputy P.M.O. :—11 *Tabanus*, 14 other Diptera, 100 Hymenoptera, 1995 Coleoptera, 3 Lepidoptera, 2132 Rhynchota, 47 Orthoptera, and 2 Centipedes ; from Uganda.

Dr. A. H. Wilson, W.A.M.S :—50 Culicidae, 17 *Tabanus*, 9 *Glossina palpalis*, 4 other Diptera, and 1 Lepidopteron ; from Benin district, Southern Nigeria.

THE BIONOMICS OF GLOSSINA; A REVIEW WITH HYPOTHETICAL CONCLUSIONS.

By William F. Fiske.

There are certain frequently observed and rather mysterious phenomena associated with the bionomics of the better known species of *Glossina*; such, for example, as the local disparity between the sexes and the apparently arbitrary distribution of the fly. It is difficult, if not impossible, to explain these, or at least no explanation has yet been put forward which is wholly in agreement with all that has been recorded of the subject. It appears necessary in consequence to consider some part of the generally accepted bionomic history of these flies as being based on insufficient evidence.

That which is here attempted is to locate the source of possible error, and to formulate an hypothetical bionomic history which shall explain the curious phenomena above mentioned, and which shall remain closely in accord with generally accepted theories. Any conclusions reached by such processes are of necessity purely tentative, and they are only of value as they invite criticism and discussion, or suggest new lines of research.

Character of recorded Movements of Glossina from place to place.

Three types of concerted movement from place to place are recorded of *Glossina*. Roubaud, in the Report of the French Commission, and subsequently, notes a seasonal migration of *G. palpalis* from permanent "belts" on the banks of large streams, to temporary "belts" on the banks of small, intermittently flowing streams, these latter being infested only during the rainy season. Various other observers, notably Macfie,* have commented upon this same type of migration, which appears to be characteristic of several and perhaps most species of *Glossina*. These movements are directly governed by the seasons, and are begun and completed within a calendar year.

In Rhodesia there is evidence that some years ago *G. morsitans* was overtaken by a widespread calamity, apparently associated with the destruction of certain game animals by rinderpest. At all events it disappeared from many localities where previously it abounded. Later reports from this region indicate that it is gradually recovering portions, at least, of the lost ground. This is indicative of quite a different type of concerted migratory movement, which is not governed by the seasons, but by something else, and which may not be completed for many years.

The third type of concerted movement is recorded by Dr. Bagshawe, who, in the course of a series of flight experiments, demonstrated that the flies were constantly moving about from place to place within infested territory. These movements were general, and a mile or more in two days was frequently covered by individuals of either sex. He found that the flies passed both up and down a

* Bull. Ent. Research III, May 1912, p. 61.

(31348—2.) Wt. P 12—12. 1000. 9/13. D & S.

river with equal freedom. They freely crossed and recrossed the Nile at Foweira (some 300 yards), and it was impossible to say that one sex was more given to wandering than the other.

Such movements as these are suggestive of no particular purpose other than to satisfy the bodily wants of the individual; they would seem to be incited by desire for food, shade, shelter, or humidity; by the fear of enemies or by the immediate necessities associated with reproduction of the species. They appear to be mere ordinary, everyday, goings and comings. There is, however, another very different sort of movement from one place to another, characteristic of many insects, including all the social and many of the solitary species. Amongst the social, the two are very sharply differentiated.

In the case of the honey bee, to exemplify this difference, large numbers of workers issue daily from the hive; they fly far afield after different kinds of bee commodities, and invariably, barring accident, they return. These are the ordinary goings and comings. One day the hive becomes the scene of unwonted activity. The queen issues, followed by a full half, perhaps, of the workers, and the whole swarm flies away without intention to return. This is a migratory or *going* movement; it is governed by instincts which ordinarily lie dormant in the individual, and which are stirred into activity by extraneous influences that are quite different from those inciting the ordinary goings and comings. These last mentioned, being stimulated by the immediate needs of the individual or the colony, are regularly or frequently recurrent, and may be repeated many times in the life of an individual. The true *goings*, on the contrary, are usually undertaken only once in the lifetime of an individual and frequently are not undertaken at all. They are specialised movements and are essentially necessary to the welfare, not of the individual, or colony, but of the species as an entity. The individual undertaking them does so at a risk to itself, which may be very great. Among the ants and termites, for example, probably not ·001 per cent. of the migrating females survive to form new colonies. It is deliberate sacrifice of individuals for the good of the race or the species.

Without exception, it is easy to differentiate between these two sorts of movements amongst the social insects; it is not so easy amongst the solitary insects. Nevertheless, the writer strongly contends that this is not due to the absence of specialised migrations, but to our imperfect perceptive abilities and incomplete knowledge of the insects themselves. It is easy to follow the movements of social species from inception to conclusion; very difficult and finally impossible to do this when solitary species are involved. Moreover, a great amount of positive evidence may be adduced to support the contention, against very little tending to controvert it.

In short, the writer believes that every species of insect must be in some manner adapted for dispersion. The contention is upheld to a certain extent by analogy with plants. It is well known that in most plants some specialised physical adaptation is provided for seed dispersion. Such adaptation may be physical (as in the instance of the gypsy moth, the young larvae of which are wind-borne) or it may be along the lines of instinctive specialisation. If it appears to be absent, its existence will either be demonstrated by research, or it will be found that the insect has such habits as to render the execution of true

migratory movements unnecessary, except on rare occasions, which may well be, since by the terms of the definition they need only be undertaken *when demanded for the good of the species*, and in response to unusual stimuli. These stimuli may be, and frequently are, a direct result of a tendency toward overpopulation of the locality from which the migrations are made.

If the theory be well grounded, then, under exceptional circumstances, if not habitually, *Glossina* ought to execute movements of quite a different character from those incited by the ordinary needs of the individual, which is immediately suggestive of the direct question, Does it do so? There is nothing recorded of its migratory movements to warrant an affirmative answer. The freedom with which the flies move about within an infested area, as demonstrated by Bagshawe, may be sufficient to provide for the seasonal movement noted by Roubaud and others, and for the more extended movements recorded of *G. morsitans* by so many independent observers.

On the other hand, the bionomics of *Glossina* are not yet very well understood, as is well exemplified by the lack of concise and satisfactory explanation for certain frequently observed phenomena already mentioned. It is certain, when the proper explanation of these phenomena is obtained, that they will be found to be intimately associated with the protection or the alimentation of the individual, or with the reproduction or dispersion of the species, and they are as likely to be associated with dispersion—including migration—as with anything else. That is to say, since our knowledge is surely lacking in some respects, it is quite as likely to be lacking in respect to the migratory movements of the flies as in any other. The writer himself believes that a connection between the phenomenon of sex disparity and specialised migratory movements is capable of logical support, as he will attempt to show in the following pages.

Local Sex Disparity of Glossina Palpalis.

It is well known that there is very often a marked disparity in the proportions of the sexes of *Glossina* caught in one particular locality. This is best established in the case of *G palpalis*, though it appears to be a common characteristic of the genus, and various suggestions have been made as to the probable explanation. That so many have been put forward is in itself sufficient to indicate the unsatisfactory character of most of them.

It is, in the case of *G. palpalis*, possible to associate sex segregation with certain types of localities. This is not possible with *G. morsitans* on the basis of data at hand, nor of any other species so well as of *palpalis*. Some striking figures are available.

Kinghorn and Montgomery* made the following catches on the island of Matondwi near the southern shore of Tanganyika :—

In July, ♂ 1282, ♀ 127 ; ♂ 91 %, ♀ 9 %
In November, ♂ 396, ♀ 5 ; ♂ 98·8 %, ♀ 1·2 %

The island is small and uninhabited, but frequented by birds, crocodiles, some snakes and a species of mouse. It is two or three miles from the shore.

* Annals of Trop. Medicine, iii, October 1909, pp. 259–276.

Kleine generalises,* stating that on the small islands in Victoria Nyanza and along the uninhabited shore males largely predominate. By a series of experiments he demonstrated that many female flies died when confined to a diet of crocodile blood in the laboratory; his results being, of three lots of 232 females each, fed for one month, 82 per cent. mortality among those fed on crocodile, as against 15 per cent. of those fed on birds, and 11 per cent. of those fed on mammals. Hence he assumes that a high mortality of females explains the predominance of males. He gives the following figures :—

Small uninhabited island near Shirati, 77 per cent. ♂ in 501 flies.

Small uninhabited island near Muansa, 87 per cent. ♂ amongst 201 flies.

Locality, inhabited, on banks of Mori River, 32 per cent. ♂ amongst 321 flies.

Flies caught during course of a year in narrow forest fringe along banks of Mori River, 50 per cent. ♂ approximately.

Degen† obtained the following results at Entebbe (the precise locality is not stated, but is presumably the uninhabited lake shore mentioned in other reports of the Sleeping Sickness Commission as having been the source of large numbers of flies collected for experimental purposes during same period) :—

In May	86·1 % ♂	amongst	726 flies.
„ June	78·8 % ♂	„	857 „
„ July	80·9 % ♂	„	796 „
„ August ...	64·5 % ♂	„	900 „
„ September ...	78·3 % ♂	„	1281 „
Average ...	77·7 % ♂	Total	4560 „

Carpenter‡ gives the following figures :—

Of nearly 5000 flies caught on Damba Island, Victoria Nyanza	78·6 % ♂
„ 6100 flies caught from July to September on mainland near Jinja	48·5 % ♂
„ over 12,000§ caught at Jinja over a longer period, but including above	47 % ♂

Of 1400 flies *bred from pupae* collected upon Damba, the sexes were nearly even. These collections were made coincidentally with the above-mentioned collections of flies.

---

* Deutsche medizinische Wochenschrift, Nov. 1909; reviewed Bull. S. S. Bur. i, no. 11, p. 452.

† Bull. S. S. Bur, vol. i, no. 12, p. 471.

‡ Rep. S. S. Comm. R. Soc. xii, 1912, pp. 79–111.

§ More complete figures than were published, kindly supplied by Dr. Carpenter from his manuscript notes, indicate the percentage at Jinja to be as follows :—

August	45 % ♂
September	51 % ♂
October	46 % ♂
November	51 % ♂
December	39 % ♂
January...	44 % ♂
Average	46 %

Bagshawe in a note appended to the above-mentioned paper of Degen's, which was reviewed by him in manuscript, states that the total of several catches made in 1906–07 on Lakes George and Edward and tributary rivers, where no crocodiles were to be found, was :—

♂ 1166, ♀ 1662 ; ♂ 41 %, ♀ 59 %

There were some localities in this region where males were in excess.

On Lake Albert and the Victoria Nile, where "crocodiles were always present and doubtless were often fed upon," the catch was :—

♂ 1951 ; ♀ 808 ; ♂ 68 % ♀ 32 %

McConnell* was "impressed with the apparent marked superiority of the males along the large rivers and of the females on the smaller streams." He caught on the Nile, in October, 5 females and 35 males ; in July, 10 females and 67 males ; in September, near the mouth of small tributaries of the Nile between Nimule and Wadelai, 32 females and 24 males ; and was sure that further upstream the proportion of females would be greater. He notes that in February (dry season) flies were rare along small streams, while in June (wet) they were common ; on the Nile itself there was no marked diminution in numbers.

Evidence of this general character might be further adduced, and it all tends to indicate rather plainly (if the disparity of the sexes is actual and not merely apparent) that :—

(1) Local disparity between the sexes is characteristic of *G. palpalis*.

(2) That it is not dependant on the season (*vide* Carpenter and Degen).

(3) That it is not due to production of the sexes in unequal numbers (*vide* Carpenter).

(4) That in some manner it is associated with conditions characteristic of the shore of lakes and larger rivers.

All these assumptions, however, depend upon the further assumption that the proportions of the sexes in a lot of caught flies is indicative of the proportions prevailing in that locality.

Are the proportions of the sexes of caught flies a correct index of the sexes prevailing in that locality?

The consensus of opinion seems to be that they are not. Theoretically, they ought not to be, if laboratory results indicating that the males feed more frequently and are generally more active than the females are properly applicable to the field. If, for example, males feed once in every two days on the average and females once in three, then, the sexes actually being equally divided, the males ought to be to the females as 60 is to 40 in the catch. Fortunately there are available precise figures, which, so far as conclusions may be drawn from a single experiment, seem to answer the question in the affirmative. Carpenter, in his Jinja marking experiment, to which reference has already been made, publishes figures from which this is deduced, as follows.

In the first place, out of a total of 6100 flies caught and marked between 27th July and 19th September the sexes were :—

2952♂, 3148♀ = ♂48·5%, ♀51·5%.

* Bull. Ent. Research, iii, May 1912, p. 58.

It is therefore definitely known that in this locality there were *marked* flies in precisely the above proportions; the proportions of the sexes among marked flies recaptured ought, then, to furnish an answer to the question. They were as follows:—

The number of marked flies recaptured between 2nd August and 7th February, inclusive, totalled 998.

487♂, 511♀ = ♂48·8%, ♀51·22%.

These figures are strikingly like those of the equation first given, but it must not be forgotton that a correction is necessary, because actually a higher percentage of the marked males was recaptured than of the marked females. Thus:—

487♂ = 16·5% of those liberated after marking.

511♀ = 15·7% " " " " "

$\frac{16.5}{16{\cdot}5+15{\cdot}7} = 51{\cdot}1$, which figure represents the actual percentage of males caught on a basis of equal numbers of both sexes liberated.

The difference between this figure and the 50 per cent. which ought to have been caught, if it were to be the true index of the proportion of males known to exist, is too small to be of conclusive value.

There is, however, to be taken into consideration a possible greater longevity of the females, which would act to increase the number of that sex recaptured over so long an interval. To ascertain the importance of this factor, the totals of flies recaptured during the two weeks immediately following the cessation of the marking of each individual lot were determined, with the following results. The total flies recaptured during these two weeks was 599 (considerably more than half the total number recaptured) made up of:—

♂298, ♀301; ♂49.7, ♀50·3

Corrected, the figures are—

♂298 = 10·1 of those liberated after marking.

♀301 = 9·2 " " " " "

$\frac{10.1}{10{\cdot}1+9{\cdot}2}$ = equals 52.3, representing the actual percentage of males caught on a basis of equal numbers of both sexes liberated.

Again the difference (1·1%) between this figure and that representing the actual percentage of males in the total recaptured during the entire period, is too small to be indicative of any considerable error arising in this instance through the greater longevity of the females.

There is still another possible source of error, in the chance that more pronounced migratory habits of the females would lead a larger relative proportion to leave the locality. This, if it were at all considerable in this instance, would make it appear that, sexes being evenly divided, more females than males would be caught. There seems no way to demonstrate whether this did or did not take place. If it *did* take place, it was almost immediately after the flies were marked, otherwise there would probably have been a greater discrepancy between the percentages for the two week period as compared with those for the total period; unless it were that migration of the females was almost precisely coincident with a greater rate of mortality amongst the males. For the present, however, we

may presume that the proportions of the sexes in a sufficiently large series of caught flies offer a very good index of the proportions actually prevailing in the locality.

The possible connection between Sex Disparity and Specialised Migratory Movement.

Obviously the female flies on an island like Damba, where both sexes are known to be produced freely and in approximately equal numbers, must either be present and not caught, or they must be absent, and as shown above, such evidence as is at hand indicates that they are not present. Partial sex segregation must be assumed to be actual and not merely apparent. If actual, the writer is unable to see how it is possible to explain it except through—

(1) Some agency which effects a greater rate of mortality upon males in one locality, and which is complemented by some other agency similarly and discriminatively prejudical to the opposite sex in another locality; or else

(2) the migration of males to, or of females from, localities where males predominate and *vice versa.*

Arguments in favour of (1) have been advanced by Kleine (as mentioned), who thinks that a diet of crocodile blood reacts more disadvantageously on females than males. His arguments are not at all convincing. They infer that the islands, where males very largely predominate are unfavourable places for the fly, on account of bad food. Nevertheless the flies remain abundant there. Suppose the average percentage of females to be 20; then upon this 20 per cent. must devolve the responsibility of maintaining the race, which is to infer that each 20 individuals must produce 160 fully developed offspring, 80 males and 80 females. Of these, 60 females (or 75 per cent.) disappear, leaving the same abundance and the same disparity in sex. Thus each female produces 8 young, or 4 pairs, and the prevalent rate of reproductivity indicated is 400 per cent. each generation.

On the mainland, on the other hand, where Kleine assumes that conditions are more favourable, 50 females would be only obliged to produce 100 progeny, or one pair each; this indicates a prevalent reproductivity of only 100 per cent., and it would appear that instead of the islands being *unfavourable* for the fly, they are (putting it in one way) *four times more favourable* than the mainland.

Kleine's conclusions not only that the flies died when confined to a diet of reptilian blood, but that even when they survived reproduction practically ceased, were later confirmed by himself and by Roubaud, and were supplemented by experiments conducted at the laboratory of the Royal Society's Commission in Uganda. The inference that islands where shore birds and reptiles only are available as hosts for *Glossina* would be unfavourable breeding localities is, therefore, wholly natural.

But, aside from the results of these experiments, all evidence points toward the islands as the most favourable localities for rapid increase, and one is forced to the conclusion that in this instance, as in many others, laboratory results cannot be depended upon implicitly as indicative of field conditions. Either the flies

must feed freely and without prejudice to themselves on birds or reptiles (monitors or crocodiles) or on both.

Dr. Duke, in a paragraph in one of his papers in No. XII of the Reports of the Sleeping Sickness Commission, specifically notes that in the open the flies were observed to be attracted in large numbers to a monitor,* but that in the laboratory they did not feed well on this reptile. Some observations are in themselves sufficient to cast some doubt on the validity of Kleine's results, in their broadest application, and to suggest the desirability of further research.

It has been observed that in captivity the flies gorge themselves with difficulty on reptilian blood, which might be held as indicative of a sluggish peripheral circulation. Perhaps the peripheral blood of a crocodile exposed to the full effect of a tropical sun flows faster, thus permitting quicker engorgements. Perhaps if the difference between avian and reptilian blood is largely one of temperature, it may disappear (so far as peripheral blood is concerned) when the reptilian host is exposed to the sun. Perhaps, even, the flies need to expose themselves to radiated heat after engorgement with cold blood, in order that digestion may properly be effected. At all events there are differences enough between laboratory and field conditions to make further and more exhaustive research desirable in an instance like this, where field observations do not support laboratory conclusions.

Carpenter assumes that some natural enemy attacking the female more freely than the male must occur on the islands and not on the mainland; at the same time he does not suggest what it may be. Aside from the need of providing some other enemy equally prejudicial to the males in places where the females predominate, this theory is against precedent, so far as the writer is aware, in the world of insects. There are precedents enough for a greater proportionate mortality among individuals of one or the other sex, but invariably, so far as any instances of this sort come to mind, the phenomenon is *preceded* by a marked segregation of the sexes. Segregation as a preliminary is thus inferentially necessary and segregation is what we are trying to explain. It is true that the females are found to adopt a somewhat different mode of life from the males, but their feeding habits appear to be markedly similar, and Carpenter himself has followed them to their breeding grounds and observed their habits at the time of parturition without discerning any enemy lying in wait for them there.

In short, the simplest and most logical of all explanations, which (because of its very simplicity, perhaps) seems to have been overlooked, appears to fit by far the most accurately all the facts in the case: *viz.* the the migration of either the males or the females to or from localities where males predominate.

Of the mutual alternatives the writer is well satisfied that the females are the migrants. There are several reasons for adopting this view.

Obviously, for one, Damba (and not improbably other islands) is actually a very favourable breeding ground, since puparia are more readily collected there than on the mainland.† On this account it would seem that migration of females

* [A similar observation has been made more recently by Dr. G. D. H. Carpenter.—Ed.]

† It is the source of supply of some 2,000 or 3,000 puparia monthly for the laboratory at Mpumu.

from such an island is more likely to occur than of males *to* the island, because this latter would seem to infer good feeding grounds and poor breeding grounds. An island in a lake is a small target to hit from the mainland as compared with the mainland from an island ; and, other things being equal, the chances seem much greater of males leaving an island, not to return, than of congregating on an island, as would of necessity be the case if it were the male that migrated.

The only analogies to such migrating tendencies on the part of the male, in the writer's knowledge, are certain little understood flights of male butterflies. What induces these is not known, and what end they serve is problematical. Probably they are undertaken for the "good of the species," and if we knew more about them we could understand.

There are many more available instances of female migration, notably amongst the parasitic Hymenoptera. These, of course, are associated with a partial segregation of the sexes, and the males remain in the locality where the females were reared. The females are fertilised as they reach maturity, and with full spermothecae become practically bisexed. They can then wander as far afield as they like and a single individual is capable of establishing a colony, or populating a continent. It is much better "for the good of the species" that the males remain where the females are the most likely to issue, than that the females should remain there and the males fly afield. Males alone cannot establish permanent colonies, except by continual migrations.

Another point to be considered is the physiological condition of the female for the first two weeks following eclosion. The male is sexually functional from the first, but the female is not. During the first two weeks she has no responsibilities whatever, except being careful for the future. Afterwards, when the rhythmic round of gestation and parturition begins, it is very different, but until then she is even more care-free than the males. It is during this period, while she is in full possession of all her powers, except of reproduction, that she may be presumed to fly far afield.

These various considerations, none of them furnishing overwhelming argument, but all together tending to support the hypothesis, would be sufficient in themselves to convince the writer of its reasonableness, if nothing more. On top of them, however, is a statement by Dr. Bagshawe, contained in a note appended to an account of his second series of flight experiments,* which is worth quoting verbatim.

"It is worth noting that while of 1,521 flies caught at certain points near Foweira, only 478 were female while of 129 caught at another point 66 were of that sex. *These figures and others in my possession lead me to suspect that as a rule where female flies are found in excess the breeding grounds are at a distance.* Thus at Harubule (Lake Ruisamba) females were on every occasion in excess : of 1,420 flies caught in a series of flight experiments 827 were female. When, however, I found the breeding ground some hundreds of yards from the scene of previous captures, I caught very quickly 61 male and 45 female flies. At a bridge over the Upanga river, much used by caravans, flies were scarce, but

* 'Observations Relating to the Transmission of Sleeping Sickness in Uganda,' by Dr. Aubrey D. P. Hodges, S. S. Bull., 1909.

females relatively numerous, 59 to 16 male. It is certain that this spot is far from breeding grounds—perhaps three miles.

"Referring to my notes of the flies caught at the spot where pupae were found, I find that in every case but one, males were in excess, and were as a rule two to one. Probably the female must be well supplied with blood to nourish her larva; if there is a scarcity she must go far afield to procure it. The male could exist with less food and need not range so widely.

"This is not so unimportant as it at first appears, for in clearing it should be our first aim to attack the breeding grounds; the sex proportion, if it has the significance which I suggest, will aid to find them. My figures are too small my data too few, to prove anything. Better observers will, it is hoped, follow up these suggestions."

The plain statement that "as a rule when females are to be found in excess the breeding grounds must be looked for at a distance," amended by the addition of the single word *favourable* before "breeding grounds," expresses in precise terms the present writer's opinion. The circumstance of so large an excess of males on so many isolated islands, at such distance from the shore as to render homing flights of the females extremely improbable, would seem to be sufficient to overthrow the theory that this segregation is merely temporary and due to the females flying further afield merely for the sake of finding food. Gravid flies would hardly cross five or ten miles of open water to a small uninhabited island merely to deposit their larvae. In short, it does not seem at all improbable that the female *Glossina* should possess a strongly developed and specialised migratory instinct which would induce her to leave the locality where she was bred, and to fly for long distances; such an instinct would probably be disassociated with any of her ordinary needs as an individual, but would correspond to that inciting the swarming flights of the bees and other social insects. It would probably lie dormant during the period when she was producing larvae, and very possibly during her entire life, unless (and this is wherein it is worthy of being termed "highly specialised") her species were approaching the limit of its possible abundance in the locality where she was reared.

There are no data at hand in any manner suggestive of the distances which might be covered, further than that afforded by the distances of the islands mentioned off shore, and this evidence is of negative value only, because it is well within the bounds of reason that the females should leave the island and yet be unable to reach the mainland.*

Are the implied migratory movements of Glossina ever encountered amongst other solitary insects?

The hypothesis of female migration involves the presumption that the islands and portions of the uninhabited shores of Victoria Nyanza, and perhaps Lakes Edward and Tanganyika, are markedly favourable for *Glossina palpalis*. It also presumes that the females of this species deliberately leave these particularly favourable regions to migrate to others less favourable. Is this reasonable?

* Migrating swarms of butterflies and moths are well known to occur far out at sea.

It certainly is—both from a logical basis, and by analogy with other insects. Though tempted, the writer believes it better not, at this time, to review some of the strong confirmatory evidence of specialised migratory flight of solitary insects, such as that supplied by the amazing rate of dispersion often characteristic of species newly introduced into a favourable faunistic region; of swarms of lowland insects entrapped on mountains; of inland insects on the seashore; of southern insects in northern localities; of the curious behaviour of many species at light, etc. He does, however, desire to illustrate the point, enlarging somewhat upon the migratory habits of a certain species of Scolytid, *Dendroctonus frontalis*.

This is a gregarious, but not a social insect, though it exhibits a slight tendency to become so. It attacks living and perfectly healthy, as well as injured and dying, pines in the south-eastern portion of the United States. The beetles are attracted to a tree that has been injured (as by lightning), usually in the midst of a pine grove or forest. They swarm over this tree, and, mining in the bark, deposit their eggs. No matter how many may be drawn to the spot, no more attack this one tree than can breed in it successfully. If there are too many, the others gather on healthy trees immediately adjacent. They do not scatter on many trees, for if they did, the pitch running into their galleries in the bark would kill or drive them out. Instead, they concentrate on as many trees as they can quickly kill, and thus soon stop the flow of resin. In about a month or six weeks the young generation begins to issue. Usually they attack the perfectly healthy trees standing next outside of those already killed, and all the trees are thus killed over an irregular area about the original centre of attraction. The beetle usually increases in numbers very rapidly with each generation, two generations nearly always, and frequently three, being passed in the manner described. A score or hundred or several thousand trees may be killed. With very rare exceptions the young beetles do not remain in the vicinity *after the second or third generations* to attack the adjacent healthy pines. They migrate instead; with a unanimity which, like the idea of rats leaving a doomed ship, it is uncanny to contemplate, they fly the spot. There may be hundreds of thousands, but they go to the last one. This migration takes place notwithstanding that the locality is proven favourable for their rapid reproduction, and though an abundance of adjacent trees remain open to attack. The issuing beetles go deliberately, and many of them go to their own destruction, because a few together cannot attack living trees successfully. They must attack in force, and when they fly they seem to scatter, since it requires a special centre of attraction to draw them together again in numbers sufficient to overcome the natural resistance of healthy trees. They cannot even breed to advantage in prostrate trees and logs, though they often attempt to do so to the destruction of their brood.

Nothing that is proposed in the way of a migratory instinct that shall lead *Glossina* to desert favourable breeding spots for less favourable is so striking an example of a specialised instinct (developed for the good of the species as a whole) as is this migratory habit of *Dendroctonus frontalis*. For if the species did not migrate in the manner described, the result would be that the entire countryside would be denuded of pine and the insect very likely exterminated as

a result, or else parasites or disease, or predatory foes would so increase as to threaten extermination. The species by migration avoids both disasters. By the aid of its migratory instincts it is enabled to maintain itself in greater average abundance, permanently, than would be possible otherwise.

Only one notable instance came to the writer's personal observation in which the migratory instinct of *Dendroctonus frontalis* lay dormant for more than two generations. This was a colony on a mountain, in a spruce forest, and the conditions were unfavourable. For three years this colony remained in one locality without notable increase or decrease. This exception is very significant. When struggling under disadvantage at home, to have tempted the dangers of migration would perhaps have been fatal. From an unfavourable locality it did not, therefore, fly, but conserved all its forces to maintain its existence against unusual odds. This is a very necessary concomitant to migration from favourable localities, because in exceptional seasons when climatic conditions are bad *all* localities may be unfavourable.

It is also to be noted that even under the most favourable conditions the migratory instinct lay dormant for one or two generations. Its existence would never be guessed by anyone studying the species for a short period in any locality, nor for an indefinite period in a locality unfavourable to the insect. Neither would it be at all likely to be observed were it not for the fact that the species is notably gregarious and thus much more easily followed in its movements.

Migration as a factor in Natural Control.

Since all insects (or other animals) possess powers of reproduction in excess of what is actually necessary to enable the species to maintain itself at a constant average abundance, it is essential for the good of each species that their powers of reproduction be curtailed, or that the superabundant individuals be destroyed. It is also essential for its greatest good, that its actual, prevailing abundance in any particular locality should be maintained as nearly as possible at the *average* permitted by the laws governing the natural equilibrium between co-existent species. Otherwise, if its numbers fluctuate over a wide range, it is liable, during years of unusual abundance, to destroy permanently its food supply,* or during years of extreme rarity, to become extinct. In order that this constant average may be maintained uniformly, some element in control of the sort which has been termed "facultative" is necessary. This, by the terms of its definition, must become relatively more efficient when the insect increases above its average, and relatively less efficient when its numbers diminish below this average. Some

* This rather frequently happens when an insect subjected to efficient natural control in one faunistic region is introduced into a new and favourable faunistic region where such control does not exist. Coccids, for example, may live for indefinite periods in large numbers on certain kinds of trees, without appreciably injuring the health of these trees, provided their increase is efficiently controlled. But without efficient control they quickly become so abundant as to cause the death of the particular varieties of plants on which they are absolutely dependent ; these plants are replaced by other varieties, and the insect is for ever deprived of its means to exist in that locality. This has actually taken place in America, following the introduction of the San José Scale, the Elm Leaf Beetle, the Gipsy Moth, etc.

parasites (particularly micro-parasites), and some predatory enemies fall within this category. Many parasites and most predatory enemies do not, because their efficiency is apt to be governed by extraneous influences more than by the relative abundance or scarcity of the insect upon which they prey. For example, a parasitic insect having two generations annually on two distinct hosts, is equally dependent on both. It cannot increase to keep pace with any unusual increase of one host unless the alternate host also increases proportionately. And to exert true "facultative" control it must be enabled to increase a little faster than its host, in order quickly to check what might otherwise be disastrous and self-destructive increase of the latter.

Thus, in the final analysis, parasites and predators exerting "facultative" control are beneficial rather than detrimental to their hosts; at the same time, since they must be supported by the sacrifice of a certain—sometimes large—percentage of individual lives, they are not unmixed blessings. A high "birth rate" and a high percentage of "infant mortality" are concomitant necessities, and economic or bionomic waste is thus entailed. Herein, to an extent which as yet does not seem to be generally realised, migration plays a highly important rôle.

It would be difficult to find two localities equally favourable to the existence of a given species of insect. Temperature, exposure, humidity, soil, etc., either exert direct influence on its fortunes, or a more or less indirect but none the less vital influence according as they favour or disfavour the growth of vegetation, and the prevalence or absence of natural enemies, such as birds, etc. An insect not given to migration must, if it be generally distributed, possess a potential reproductivity sufficient to enable it to hold its own by mere force of numbers (by high birth rate) in unfavourable localities, and this birth rate must equally be checked by equally high "infant mortality" in the favourable localities through "facultative" control. With an insect given to migration (more especially when this migration is governed by a specialised instinct which lies dormant when conditions are unfavourable to rapid increase, and the species is locally or seasonally less abundant than usual), it is possible very largely to avoid this sacrifice of life by the movement of superfluous individuals from particularly favourable to less favourable localities. Disastrous superabundance is thus prevented on the one hand, and on the other the superabundant individuals (which must be disposed of in some manner) are so disposed of as to be of distinct utility* to the species, as an entity, by permitting it to maintain itself in greater abundance in less favourable localities.

The broad general subject of "natural control" or, expressed in another way, of the laws governing the natural equilibrium between co-existent species, whether of insects or of the higher animals, of plants or of micro-organisms, has received much attention of late from a wide variety of sources. In entomology

* The writer has his own method for basing judgment on what is of utility or benefit to a species (whether of insect or other animal), which it may not be out of place to outline. It is, briefly, a presumption that the aim in life of every species is to multiply and populate the earth —to exist permanently in the greatest numbers possible, over the widest territory possible. Anything favourable, in its final analysis, to greater local abundance or wider geographical dispersion is held to be advantageous—or vice versa.

this is manifested by the growing interest in parasites and in micro-parasites as factors in "natural control" of noxious insects; in medicine, by the similarly increasing interest in prophylaxis and prevention of disease through the direct or indirect suppression of micro-parasitic organisms which exert the same sort of "natural control" over our own species; in general economics, through the increasing measure of support continually given to research along the just-mentioned lines in entomology, in medicine, etc.

In entomology, the writer feels personally convinced, too much importance, relatively, has been devoted to the various types of pathogenic parasitism, and too little to certain other factors in the natural control of injurious insects, of which migration appears to be as important as any. This first became apparent when studying the natural control of the brown-tail moth, an exceedingly noxious insect much given to migratory flights of longer or shorter duration. It was increasingly evident, as the problem of its suppression was studied, that certain natural "reservoirs" existed. These were represented in France by the hawthorn hedges; in America by certain types of forest and varieties of trees. In such places the species found all things favourable to increase and from them it spread to infest other generally unfavourable localities—in France, the nurseries from which it was being sent on the young trees to America—in America, to other types of forests, to other species of trees, and even to geographical regions where it might be unable to exist permanently were these reservoirs eliminated. Once the idea was conceived, the general principle involved (of control over increase through migration) was found to be easily applicable to what was known of the bionomics of a wide variety of insects. Nowhere does it appear more closely to fit than to what is known of the bionomics of *Glossina* in general, and the East African race of *Glossina palpalis* in particular. It is, however, necessary that the general beliefs that wide bodies of water form natural barriers to migration and that mammalian hosts are preferred by the fly to avian or reptilian be considered as unsupported by sufficiently valid evidence.

With these obstacles to the validity of the hypothesis of sex migration removed, this not only offers an explanation for the otherwise puzzling phenomenon of sex disparity, but it accords well with the remarkably low potential reproductivity of the fly—its low "birth rate"—and, better yet, with the curious lack of any form of pathogenic parasitism, so far as published records indicate. This seeming absence of parasites is unusual amongst insects, and if actual and not merely apparent and due to their having been overlooked, renders necessary some other form of facultative control; a lack which may easily and well be supplied by the migratory habits of the female.

Possessed of this discriminative instinct, the species would be enabled to avoid the dangers contingent upon overpopulation of particularly favourable localities—represented by the lake islands—and to dispose of the superabundant individuals to its own advantage (as a species) by keeping permanently or temporarily populated portions of the mainland, where, except for the continual influx of immigrants, it would quickly become extinct. It does this without undue sacrifice of its own life-blood to support the parasites which might otherwise be necessary to prevent its increase to such numbers as to destroy its own hosts or

to drive them away from favourable breeding grounds. It does it, moreover, without wasting the blood of its hosts, to support the individuals destined thus to be sacrifled.

Whether the hypothesis is eventually supported by the facts or not, a more beautiful example of facultative natural control by this highly important and most beneficent of all agencies would be difficult to conceive.

Possible economic application of female migration hypothesis.

This is wholly dependant on its being established in the first place; upon the actual conditions found to exist in any particular fly-infested region in the second; and finally, and most important of all, in the natural resources awaiting and ripe for economic development in that region. In consequence, any discussion of the subject is pure speculation and nothing else, worth less than nothing except as it may be suggestive of lines of research leading to results capable of direct economic application.

The hypothesis itself, if soundly based, ought easily to be capable of establishment. The actual conditions prevailing in a given infested area, as well as the maximum migrating range of the fly, could then be secured without very great outlay by a systematic survey of the fly spots and determination of the sex disparity prevailing. Localities in which males predominate on an average throughout the year (it would be much better to have figures for several years) would then be held favourable for the fly; where females predominate, the opposite. That is to say, the aggregate control over increase exerted by unfavourable breeding grounds, by such natural enemies as birds, ants, *Bembex*, etc., by unsuitable or irregular food supply, by unfavourable conditions as regards humidity, shelter from the sun, etc., would permit increase in one locality and not in the other.

The *relative* suitability of different localities would, moreover, be roughly indicated in the manner already used in the attempt to controvert Kleine's argument that the islands were unfavourable breeding grounds. Thus if the males averaged 80 per cent. of the total, year in and year out, the reproductivity of each female would stand at 400 per cent. or four pairs; if 75 per cent. were males, at 300 per cent.; if less than 50 per cent., there would be less than 100 per cent. reproductivity, and a proportionate decrease in abundance. For example, 47 per cent. of males, as at the locality near Jinja where Carpenter noted the sex of 12,000 flies over a period of some seven months, would indicate a reproductivity of 90 per cent. according to this method of approximating it. This, if correct, would mean that unless some other agent than migration, and like it, exerting facultative control, were in part responsible for conditions so unfavourable to increase, the species would decrease in the last-mentioned locality at the rate of 10 per cent. of its prevailing numbers for each generation of the fly, and that it would finally cease to exist, provided immigration was prevented.

If this could be established as a feature in the bionomics of *Glossina*, it would seem to have great potentialities for economic application, especially in connection with a campaign for the suppression of the fly through clearing methods.

Another fertile field for bionomic research would be opened up by the establishment on a firm basis of the female migration hypothesis. There has

long been something of a mystery associated with the local distribution of *Glossina*—not only of *G. palpalis*, but of other species. Frequent comment has been made of the absence of fly from localities which seemed in every way as suitable for it as others in which it was common. If it is shown that the fly may actually be present permanently and abundantly in localities which are actually unfavourable to its increase, then a new basis for comparison is at once necessary.

It may very easily be that some localities now fly-free are actually more favourable than other localities now infested; that they owe immunity to nothing more or less than distance from any such particularly favourable localities as the immediate environs of the Victoria Nyanza seem to furnish in numbers. It is significant that the only feasible method for reducing the numbers of *G. palpalis* yet suggested is based on what is, in effect, a minor detail in the habits of the adult, *i.e.*, its aversion to localities devoid of shrubby undergrowth. This has nothing directly to do with its breeding habits, its natural enemies, or any other of its very many bionomic characteristics. It appears probable when the favourable breeding grounds are differentiated from, and then compared with, the unfavourable, that constant differences will be noted of as much importance, economically, as the one point of difference between localities frequented and unfrequented by adult flies.

That which has been written concerns *G. palpalis* and more particularly the East African race of this species. To what extent it might apply to other species or races, as for example to *G. morsitans*, is wholly problematical. An attempt has been made to review what is known of the bionomics of *G. morsitans* and to compare its bionomic history item by item with that of *G. palpalis*, known or assumed. There are some marked differences, but there are more points of resemblace than points of difference, so far as what is actually known of both species makes direct comparison possible, and it would seem fairly safe to presume that more points of resemblance than of difference will be found as additions are made to our present knowledge.

Such an assumption is upheld by the circumstance that there is a similar local disparity in the sexes (real or apparent) awaiting explanation; a similar absence of pathogenic parasites, so far as records go; and a similar unexplained absence of fly from localities which appear favourable to its existence. The chances would thus appear better than even, that any explanation of these phenomena in the case of *G. palpalis* will similarly apply in the case of *G. morsitans*.

Summary and Conclusions.

These are presented more as a target for criticism than in the expectation that they will be accepted as a correct exposition of *Glossina* bionomics.

(1) In East Africa *G. palpalis* finds the most favourable conditions for rapid increase in such localities as are represented by certain islands in the Victoria Nyanza and certain spots along the uninhabited lake shore. Here it increases rapidly from generation to generation.

(2) Inferentially, birds or the large reptiles, and not mammals, furnish the most favourable food. It is suggested that the results of laboratory experiments to determine the effect of a diet of reptilian blood do not apply literally to the conditions in the open.

(3) The disparity between sexes in the catch seems to be a fair index of the disparity prevailing in the locality.

(4) The superabundant individuals reared under most favourable conditions are disposed of by migration of the females, and the disparity between the sexes is thus to be explained.

(5) These migratory flights of the females are quite distinctly different from the ordinary goings and comings in which both sexes participate. They probably take place during the period following eclosion and fertilisation and preceding full sexual maturity. The general tendency is to pass from more to less favourable breeding grounds.

(6) There is no evidence as to the extent of migratory range. Wide extents of water or of open country probably offer no obstacle to flights of this character.

(7) Through possession of such habits the species would theoretically be enabled to dispense with any other element of "facultative control" over increase. The failure to discover efficient parasites, pathogenic micro-parasites, specialised predatory foes, or other natural enemies capable of exercising such control, might thus be explained.

(8) In the absence of efficient facultative control, it must be assumed that, in general, localities where males predominate are favourable and where females predominate unfavourable to increase; that the species maintains itself in the latter only through immigration, and that it would become locally extinct were this to cease.

(9) When localities actually favourable to increase are compared with localities actually unfavourable it is not improbable that points of difference will be discerned, which may be of value for economic application. Failure in the past to discover constant points of difference between given localities that are fly-free and fly-infested is not improbably due to the fact that both may be equally unfavourable, but that certain localities are fly-free simply owing to their distance from really favourable localities.

(10) The extent to which these tentative conclusions regarding the bionomics of *G. palpalis* in a certain geographical region will apply to the same species in other regions, or to other species, is wholly problematical. Different species will probably differ bionomically in detail, but the broader general principles of most favoured hosts, of most favourable type of breeding ground, of automatic control over increase through emigration, etc., if substantiated for one species, will probably apply to all nearly related or perhaps all species in the genus.

ON THE CHEMOTROPISM OF INSECTS AND ITS SIGNIFICANCE FOR ECONOMIC ENTOMOLOGY.

By Ivar Trägårdh, D.Sc., F.E.S.,

Experimentalfältet, Sweden.

In a highly interesting article in a previous number of this journal (vol. iii, p. 343) J. Dewitz discussed "The bearing of physiology on economic entomology," and gave in this connection, amongst other things, an account of the various kinds of tropisms and their use, besides which he also pointed out the necessity for studying these for the purpose of discovering weapons for fighting noxious insects. It strikes me, however, as if the importance of chemotropism had not been emphasised in this survey as in my opinion it ought to have been, and the purpose of these modest lines is partly to draw attention to two important researches in this branch of science, recently carried out independently of each other, partly to point out that with the aid of chemotropism we shall in all probability be able to discover new weapons for the fight against noxious insects.

By the term "chemotropism" is meant, as it is well known, the automatic orientation of the animals to any olfactory sensation in such a manner that both sides of the body are struck by the lines of diffusion at the same angle. Theoretically, when a substance diffuses an odour, fine particles are ejected in straight lines, but in reality the air currents cause the lines to deviate from their straight track, and for that reason we cannot expect insects in the case of chemotropic movements to follow such straight lines as in the case of phototropic movements.

Chemotropism is a very important factor in the life of insects, and its positive action is especially evident in the following circumstances: in the search of the sexes for each other; in their search for food; and in oviposition. On the other hand, the occurrence of negative chemotropism is demonstrated by the fact that many insects protect themselves against their enemies by discharging evil-smelling fluids, and so forth.

Entomologists have been aware for a long time that the males of certain species of moths are attracted from a great distance by the females, and the phenomenon has been confirmed by many experiments. It is perfectly well known also that the antennae of many males are far better developed than those of the females, and that olfactory organs of different kinds are found both in male and female Lepidoptera. All these arrangements go to prove that chemotropism plays an important part amongst the Lepidoptera from a sexual point of view. It is, however, quite obvious that sexual chemotropism cannot be utilised in practice, unless the females were attracted by the males. But this appears to occur only in extremely rare cases (*Hepialus hecta*, according to Degener).

The position is quite different in the case of that form of chemotropism which guides the insects in their search for food, or the females when ovipositing; and the former action has actually been turned to practical use for a long time by

collectors who employ traps with strongly smelling baits. Numerous observations have shown how coprophagous Lamellicornia and carrion-bettles are capable of detecting a long way off the smell of excrement and carrion; similarly in the case of insects, the females of which oviposit upon substances or plants that serve both themselves and their larvae as food, it has been recognised that it is the odour that guides them.

But in the case of insects, the larvae of which have quite another diet from that of their parents, *e.g.*, parasitic Hymenoptera which oviposit upon a certain insect, or butterflies that lay their eggs upon a single species of plant, or upon the plants of a single genus or family, we have been satisfied with saying that their actions were instinctive, without attempting to analyse which definite elementary instinct or instincts, *i.e.* tropism, had guided their apparently purposeful action. One of the reasons for not thinking of chemotropism as one of the active factors in these cases, is probably that it was impossible for a human being to detect any odour. And yet it is evident that it is chemotropism which in the first instance guides the majority of these insects to the right spot for depositing their eggs, even if, after they reach it, their touch or some similar sense guides them, when it is a case of perhaps finding the very spot upon the plant where the egg has to be deposited.

If we consider that there are some ICHNEUMONIDAE that lay their eggs deep down in the trunks of trees upon *Sirex* larvae, it is of course quite evident that neither sight, nor hearing, nor touch is able to assist them in ascertaining that a larva is living in the tree; but it must be a certain odour given off by the larva which is sensed by the parasitic insect. In the same manner it is probable that those parasites which attack leaf-mining larvae in the first instance are guided by their sense of smell. And finally we have every reason for assuming that it is the same sense which on the occasion of ovipositing guides all those insects whose larvae are herbivorous to their respective food-plants.

This assumption is confirmed by some experiments made during the last few years. In the year 1910 Ed. Verschaffelt[2] published in Amsterdam his investigations into the factors that determined the choice of food of certain butterfly larvae. He experimented with the caterpillars of *Pieris brassicae* and *P. rapae*, which prefer cruciferous leaves to all others. They eat, however, also leaves of *Tropaeolum* and *Reseda*, and the composition of their bill-of-fare throws a good light upon the determinative factors of their choice, for a group of glucosides, the mustard-oils, is common to all these.

In order to ascertain how strongly the mustard-oil attracted the larvae, Verschaffelt smeared a dough of *Bunias orientalis* upon some leaves of other plants which the larvae had previously refused to eat. Thus treated, the leaves were attacked and devoured with evident appreciation. In some instances the attempts failed, however, *e.g.*, with leaves of *Salvia officinalis* and *Menyanthes trifoliata*; but this was certainly due to the occurrence of other substances* in these leaves which exercised a more strongly negative reaction than the *Bunias*-dough had been able to effect in a positive direction. In order to obtain convincing evidence that it was really mustard-oil and not perchance some other

* In the *Salvia* leaves there occurs a volatile terebene, called tujon.

substances likewise common to the Cruciferae, *Reseda* and *Tropaeolum*, which exercised their attractive force upon the *Pieris* larvae, Verschaffelt took a solution of sinigrin, which forms the glucose part of black mustard, and with a brush spread it upon some leaves of other plants which the larvae had refused to eat without previous treatment. These were then devoured with relish. From these experiments it will be clearly seen that the *Pieris* larvae exhibit a strong positive chemotropism* towards a group of substances, mustard-oils, and that it is the presence of these substances in the leaves of their food-plants which makes them palatable for the larvae.

In the same manner Verschaffelt showed, by experiments with the larvae of a herbivorous Hymenopteron, *Priophorus padi*, which attacks the leaves of some members of the natural order Rosaceae, that in these there occurs a glucoside, amygdaline, which forms the attractive substance. It is hardly too daring to predict that further investigations will merely go to confirm these observations, and that the choice of food by herbivorous insects is determined by the occurrence of certain specific organic substances in the plants. So far only a beginning has been made with this problem; but it is certain that co-operation between vegetable chemists and entomologists in this question will prove highly profitable.

The above-mentioned experiments do not, however, give an answer to the question as to what factors guide the females of the herbivorous species in their ovipositing, and it is a fact that in the majority of cases the larvae have no option in the choice of their food. The selection is made by the females, and were their instinct not reliable, the larvae would perish. I am more especially thinking of the leaf-miners which, at least when quite young, would not be able to quit the plant upon which they had been deposited in the egg-stage.

It has been frequently observed that when moths are trapped with baits—in opposition to what occurs when catching with lanterns—a very large percentage of fertilised, egg-laden females is obtained, and this point seems very suggestive. Dewitz considers that this is due to the fact that the females are in the habit of feeding before ovipositing, and that they are attracted by the bait because the smell of the latter is like the odour of the fluids in their food. This is quite possible; but we might also imagine that the attraction is due to the odour of the bait being like that emanating from the food-plants of the larvae, and it would appear to be an easy matter to solve this question on the basis of Verschaffelt's researches by enticing the females of *Pieris* to oviposit upon other plants than the normal food-plants by means of sinigrin, for example.

No such experiments have, however, as yet been carried out, so far as I am aware, but in some cases where the larvae and adults have nearly the same diet, the attempt has been made to deceive the females into ovipositing by the aid of certain organic substances extracted from their food.

F. M. Howlett last year published the results of some experiments of this kind.[3] He succeeded in enticing *Sarcophaga* to oviposit in a bottle containing scatol, a pungent substance found in excrement, and which is the product of

* This term is not used by Verschaffelt, who regarded the problem merely from the standpoint of vegetable chemistry.

decomposition of albuminous substances. Furthermore, he lured *Stomoxys calcitrans* into laying eggs upon a cotton rag drenched with valerianic acid, a substance found in decomposing vegetable matter.

Howlett then goes on to discuss the theoretical significance of these experiments. He points out that our own sense of smell appears to be limited to substances that possess a molecular weight of about 30 or more, whilst we are unable to perceive any smell in substances with a less molecular weight, even if they exercise an irritating influence upon our nasal mucous membrane.

It is probable that the sense of smell in insects has been developed only in certain directions, and that they are extremely sensitive to the odour of certain substances, whereas others do not make any impression on them. In other words, we may assume that every species is adapted merely to react to the odour of certain organic substances, either positively or negatively, and that these are probably substances which under normal conditions play a part in their life. There ought, therefore, to exist a certain correlation between specialising with regard to food and the sense of smell. The odour of organic matters again is due to the occurrence in them of certain specific chemical combinations, *e.g.*, organic acids, amines, terebenes, phenols, glycosides, etc., which are characterised by a certain structure and stratification of the atoms.

Howlett did not know of Verschaffelt's work, but we discover immediately how remarkably well the two researches complete each other, and even if the chain of evidence is not fully perfect as to which factor determines the females of herbivorous species in the selection of the food-plant for their larvae, we may yet be permitted to draw the following hypothetical conclusions. The ovipositing of the females is guided, even in those cases where the larva has a diet different from that of the adult, by chemotropism, and this latter is correlated with the food of the larva in such a manner that, if the larva is a univor, it is only *one* specific organic union in the food-plant which attracts the female. If the food of the larva consists of several species of one and the same genus, or of different genera within one or several families, then it is an organic union or group of such, common to all these, to which the species reacts positively.

As an example of how strongly specialised the sense of smell can be in insects, we may mention the ants. It is a well known fact that the members of the same species attack each other with the greatest fury if they only come from different nests, and this has been proved by experiments to be due to each member of a community of ants possessing its special nest-odour, by the aid of which it is able to distinguish friend from foe.

After this short account of what we know of the chemotropism of insects, we may pass on to the question as to whether it can possess any importance for economic entomology. From a theoretical point of view, we ought, if the above conclusions are valid, to be able to discover in the chemotropical reactions of insects in many cases a superb weapon in the fight against noxious species. For it has always been considered that prevention is better than cure, and of all methods in preventing devastation that is undoubtedly nearest to the ideal in which we succeed in capturing the females ere they have had an opportunity of ovipositing. And we shall probably be able to effect this if we succeed in isolating the organic substances in the food-plants of the larvae, towards which

the females react with a positive chemotropism, and with which a kind of trap might be prepared.

In reality such methods have for a long time been practically utilised without the theoretical foundation of the idea being understood. If, for example, we lay out pieces of freshly pulled bark to act as traps for catching the pine weevil, or make use of trap trees for bark-beetles, we are utilising in reality the specific chemotropism of the animals.

But in no instance has as yet an attempt been made to ascertain what definite organic combination in one plant or another chemotropically influences a certain insect; still less has an attempt been made to produce the same synthetically and make practical use of it.

In my opinion, however, the investigations of Verschaffelt, Dewitz, and Howlett, if regarded in the light of the researches of physiologists into chemotropism, are of an importance which cannot be overestimated, and will guide practical entomology into new lines. Intimate co-operation between vegetable chemistry and entomology in these questions will surely provide us with good weapons in our fight with many insects, against which we are at present absolutely helpless.

Bibliography.

1. DEWITZ, J. The bearing of physiology on economic entomology.—Bull. of Ent. Research, vol. iii, pp. 343–354. London, 1912.
2. VERSCHAFFELT, ED. The cause determining the selection of food in some herbivorous insects.—Konink. Akad. van Wetenschappen te Amsterdam, Proc. of the Section of Sciences, vol. xiii, part 1, pp. 536–542. Amsterdam, 1910.
3. HOWLETT, F. M. The effect of oil of citronella on two species of *Dacus*.—Trans. Ent. Soc. London, 1912, pp. 442–448.

ON THREE NEW SPECIES OF GAMASID MITES FOUND ON RATS.

By STANLEY HIRST.

(*Published by permission of the Trustees of the British Museum.*)

The great majority of the GAMASIDAE are not parasitic in habit, but a number of true parasites belonging to this family are known to occur on vertebrates and on arthropods. They are most often found on birds and small mammals, especially on bats and rodents.

Gamasid mites belonging to several different genera are known to occur on the species of rats which frequent human habitations; the following is a list of these genera :—*Myonyssus*, *Leiognathus* (=*Liponyssus*), *Dermanyssus* (*Liponyssoides*), *Laelaps* and *Haemogamasus*. In view of the possibility that some of the mites of this family found on rats may convey plague or leprosy to human beings, special attention ought to be directed in future to their habits and distribution. Numerous cases of *Dermanyssus avium* attacking human beings have been recorded by various authors and more than one species of *Laelaps* and of *Leiognathus* have been found on man,* although, of course, not their proper host.

In the genus *Laelaps* the fingers of the chelicerae (mandibles) of the female are rather short, fairly stout, and armed with distinct teeth (instead of being slender and pointed, as is usually the case in *Leiognathus*, or united to form a very long style, as in *Dermanyssus*); one would imagine, indeed, from the general appearance of the chelicerae, that the mites of this genus were not parasites, but preyed upon other arthropods. Dr. C. Tiraboschi† and the late Mr. W. W. Miller‡ state in their papers, however, that species of *Laelaps* occurring on rats are true parasites, and suck the blood of their hosts. In other details of structure, especially in the presence of a series of minute denticles on the ventral surface of the capitulum, most of these parasitic species of *Laelaps* present so much resemblance to *Leiognathus*, etc., that I think they should be placed in the same subfamily (DERMANYSSINAE), instead of in the separate subfamily (LAELAPTINAE), in which they are usually put.

The figures of *Dermanyssus muris* have been drawn by Mr. Horace Knight, those of *Laelaps echidninus* by Mr. Engel Terzi.

---

* P. Mégnin's "Parasites et Maladies Parasitaires" (1880) and Prof. L. G. Neumann's "Treatise on the Parasites and Parasitic Diseases of Domesticated Animals" (English Edition, 1892). Neumann has also published an account of a case in which *Laelaps stabularis*, Koch, was found in great numbers in a house and seriously affected the health of one of the inmates (C. R. Soc. Biol. (9) v, 1893, p. 161). See also my little paper "On two new Parasitic Acari of the genus *Leiognathus*, Cn." (Bull. Ent. Res. iii, 1912, p. 369). A number of instances of the Gamasid parasites of rats and birds making attacks on human beings in Australia are given by Dr. J. Burton Cleland in an interesting paper entitled "Injuries and Diseases of Man in Australia attributable to animals (except insects)" (J. Trop. Med. xvi, no. 3, 1913, p. 43).

† Arch. Parasit., Paris, viii, 1904, p. 342.

‡ Washington, D. C., Treas. Dept.. Pub. Hlth. Mar. Hosp. Serv., Hyg. Lab., Bull. no. 46, 1908, p. 25.

Genus Dermanyssus.

Subgenus *Liponyssoides*, nov.

Capitulum somewhat longer and narrower than is the case in the typical species of *Dermanyssus*. Chelicera of male furnished with a long accessory process (flagellum) which is armed with a little tooth.

Dermanyssus (Liponyssoides) muris, sp. n. (figs. 1–2).

♀. *Body* rather long oval, but its exact shape varies considerably, for it is sometimes much swollen with ingested blood. *Scutum* long and rather narrow, leaving much of the dorsal surface uncovered; it is wedge-shaped, being gradually and progressively narrowed posteriorly; the posterior end is very slightly rounded (almost truncate). A number of fine hairs, of moderate length, are present on its surface; for the greater part of the length of the scutum these hairs are mostly arranged in transverse series of four or six hairs or in pairs; on

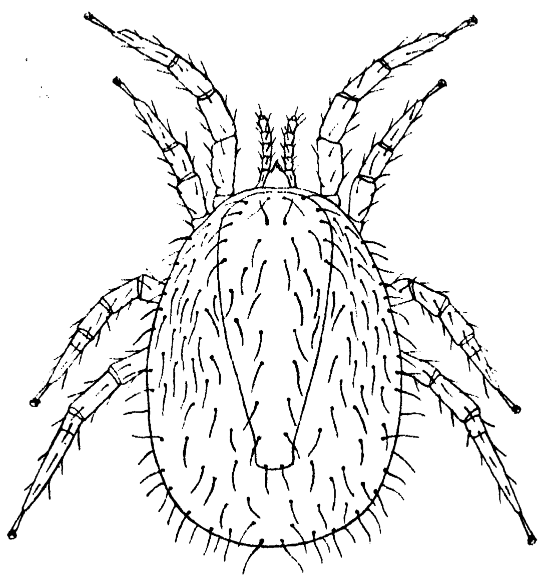


Fig. 1.—*Dermanyssus* (*Liponyssoides*) *muris*, Hirst, dorsal view of female.

the posterior part of the scutum there are only pairs of hairs. *Sternal plate* trapezoidal in shape, and furnished with three long fine hairs on each side. The plate which is situated behind the genital operculum is long, narrow and wedge-shaped, gradually diminishing in width posteriorly, its end being blunt; there is a pair of rather long fine hairs on this plate and they are placed opposite the fourth coxa. *Anal plate* heart-shaped and furnished with the usual three hairs, which are rather long and fine; posterior margin of this plate punctured in a striate fashion. *Peritreme* long, extending as far forwards as the coxa of the second leg or slightly beyond it. Some distance in front of the anterior end of the peritreme, there is present (at least in the specimens from Colombo) a little round eye-like structure, but owing to its position it is very difficult to see.

Anterior surface of *second coxa* armed dorsally with a sharp forwardly directed spur; there are no spurs on the other coxae. *Capitulum* more elongated than is the case in *D. gallinae*, Redi, and the paired hairs on its ventral surface are long and very fine; the narrow central strip of the ventral surface of the capitulum is armed with a file of minute denticles. *Chelicera* very long and styliform, as in *D. gallinae;* one edge is strongly chitinised, but the greater part of the width of the chelicera is very thin and transparent. *Colour* (in spirit) reddish brown; occasionally two or more whitish spots or patches are visible on the surface of the body, but they are evidently due to internal glands showing through the skin. *Length* of body 1·35 mm.; of scutum 0·9 mm.

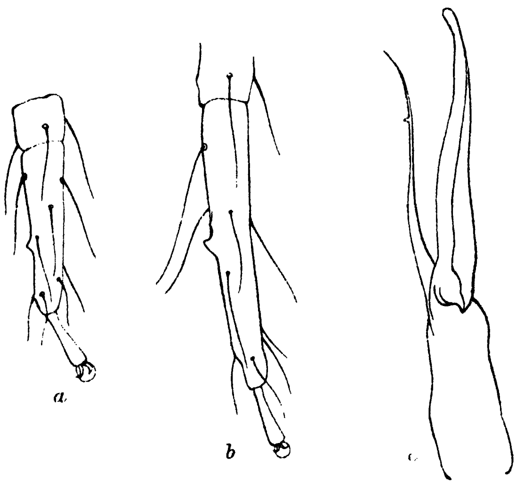


Fig. 2.—*Dermanyssus* (*Liponyssoides*) *muris*, Hirst, ♂; (*a*) tarsus of third leg, (*b*) tarsus of fourth leg, (*c*) chelicera.

♂. *Chelicera* rather long, but very much shorter than that of the female; both fingers can be distinguished, but they are placed very close together; near the base of the fingers, a long slender process, of about the same length as the digits themselves, is given off, and it is furnished with a sharp little tooth (fig. 2*c*). *Tarsi* of the legs of the third and fourth pairs long and slender; and there is a little conical projection near the middle of the ventral surface of the distal portion of these tarsi (fig. 2*a*, *b*).

The only male specimen of this species in my possession is rather badly damaged, hence I cannot describe the plates of the body.

Material. A number of specimens collected on rats (*Mus rattus*) at various localities in the city of Madras (Triplicane, Parktown, Chepawk, Georgetown (Lothwell Market), Pursewakum, Vepery); also specimens found on *Mus rattus* at Colombo. These were received from *Dr. L. F. Hirst*—the Colombo examples being collected by him. Since writing the above description I have received a very large number of specimens of this species taken on *Mus rattus* at Assiût, Egypt. My best thanks are due to Dr. C. J. Martin, F.R.S., and Mr. A. Bacot for their kindness in lending me this material.

This and the following new species of *Dermanyssus* are apparently found only on rats, and this is somewhat remarkable, for birds are the normal hosts of all the other species of *Dermanyssus* hitherto described. Ingested blood was present in both the male and female specimens.

Dermanyssus (Liponyssoides) aegyptius, sp. n.

♀. Closely allied to *D.* (*Liponyssoides*) *muris* but differing in the following respects:—*Scutum* much narrower, the posterior part of it being very much narrowed (almost linear); arrangement of hairs on scutum very similar, however, to what it is in *D. muris*. *Sternal plate* with only two pairs of hairs, but there is a pair of little plates behind the sternal one, and each of them bears a hair. The plate which is situated behind the genital orifice is sharply pointed at its posterior end. *Anal plate* quite different in shape from that of *D. muris*, being long ovate instead of heart-shaped. There is no spur on the anterior surface of the coxa of the second leg. *Length* of body 1·9 mm.

Material. I have examined specimens of this species taken on the following hosts—(1) *Acomys cahirinus*; over two hundred specimens captured at Assiût (and on the feluccas at that town); also at Kous. (2) *Mus rattus*; numerous specimens found on this host at Assiût, and a few at Kous. (3) *Arvicanthis* sp., in houses at Assiût. Also some specimens from El-Weladie; no host given. It is through the kindness of Dr. C. J. Martin, F.R.S., and Mr. A. W. Bacot of the Lister Institute, that I have had the opportunity of examining these specimens: they were collected by Dr. Petrie.

The above description is of a preliminary nature; the species will be described at greater length and figured in another paper.

Leiognathus bacoti, sp. n.

♀. *Scutum* long and narrow, leaving most of the dorsal surface uncovered; it is widest at a short distance from the anterior end, diminishing gradually (but not in a very regular manner) in width posteriorly, the terminal part of it being quite narrow. Hairs on the scutum of moderate length, on the anterior half of it they are fairly numerous, but posteriorly they occur only in pairs; there are six of these pairs of hairs on the posterior half, three of them being placed close together on the margins of the extreme end of it. *Sternal plate* trapezoidal in shape, and furnished with three pairs of fine and fairly long hairs, those of the posterior pair being situated at the posterior angles. Genital operculum continued posteriorly by the usual plate, which is long, slender and rather sharply pointed at the end; a pair of hairs is present on this plate, opposite the fourth coxae. *Anal plate* long and pear-shaped, its posterior end is finely striated; the usual three hairs are present on this plate. Fingers of *chelicera* short and apparently without any teeth. *Coxae* of legs without any well-marked spurs. *Peritreme* apparently extending as far forwards as the anterior surface of the first coxa. *Length* ·8 mm.

Material. Five female specimens found on *Mus norvegicus* on the feluccas at Assiût (Dr. Petrie).

This species seems to resemble *L. saurarum*, Oudemans, somewhat in the narrowness of its scutum, but differs from that species in many other structural details.

Laelaps echidninus, Berlese (figs. 3, 4).

♀. *Body* oval in shape. Almost the entire dorsal surface is covered by the *scutum*, but a marginal strip of soft skin is left unprotected. Hairs on scutum long, fine and fairly numerous. *Ventral plates* with much finer hairs than in *L. agilis*, C. L. Koch. *Peritreme* long, its anterior end being situated opposite (or a little in front of) the coxa of the first leg. *Coxa* of first leg furnished posteriorly with a strong seta, of moderate length, and also with a stout and rather blunt little thorn. Second and third coxae each with a similar thorn on their posterior surfaces. Fourth coxa with a smaller and more slender thorn (spine). The narrow central strip of the ventral surface of the *capitulum*

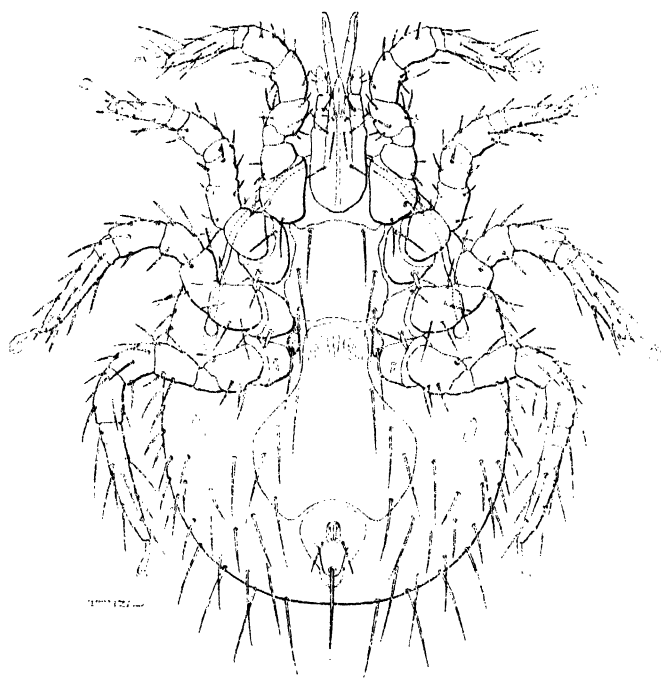


Fig. 3.—*Laelaps echidninus*, Berlese, ventral view of female.

is armed throughout its length with minute denticles. Movable finger of *chelicera* with two little teeth, which are placed close together; the distal end of this finger is slightly curved. Immovable finger with a single minute tooth. (For the shape of the seta of the immovable finger *see* fig. 4). *Colour* brownish. *Length* of body 1·1 mm.

Material. Numerous specimens found by the author and his brother (*Dr. L. F. Hirst*) on rats (*Mus norvegicus*) from Barking Creek and other specimens captured on rats taken at Tilbury Docks (*Dr. Willoughby*). We are indebted to Dr. Herbert Williams (principal Medical Officer of Health for the Port of London) for his kindness in forwarding the Tilbury specimens to the Museum. Also specimens taken on *Mus norvegicus* in the United States

(*Hugh Glasgow*, presented to the Museum by the Imperial Bureau of Entomology) and others captured on *Mus rattus* at Colombo (*L. F. Hirst*).

Dr. A. C. Oudemans states* that *L. echidninus*, Berl., is identical with *L. hilaris*, Koch. He kindly lent me for a short time some specimens of the species which he considers to be *L. hilaris*. The female specimens which he

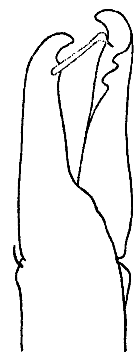


Fig. 4.—*Laelaps echidninus*, Berlese, ♀, side view of chelicera.

sent me (taken on *Mustela vulgaris* at Gramsbergen) represent a species which is certainly quite distinct from *L. echidninus*, the sternum of these specimens being much wider as compared with its length, and the spines on the tarsus of the fourth leg much shorter as compared with the length of this segment of the limb, than in *L. echidninus*.

Laelaps agilis, C. L. Koch.

Material. A number of specimens of this species captured on *Arvicola* sp. and on *Talpa europea* at Grunberg, Germany, 9th July 1910 (*R. E. Hoffmann*), have been presented to the British Museum by the Hon. N. C. Rothschild. We have also some mounted preparations and a number of specimens in spirit taken on water voles (*Arvicola* sp.)—these specimens have no history or locality, but probably they are English. Dr. A. C. Oudemans has also lent me some specimens captured in Holland.

* Ent. Ber. Nederland Ver. III, 1912, p. 262.

PROGRESS IN THE STUDY OF VERRUGA TRANSMISSION BY BLOODSUCKERS.

By Charles H. T. Townsend,

Director of Entomological Stations for Peru.

(Plates X—XII.)

Referring to the papers by the writer in the *Inca Chronicle* (March 1913), and the *Journal of Economic Entomology* (April 1913), it is time to make the announcement that the experiments under way during May and June 1913, have so far been entirely negative as to the transmission of verruga by ticks or mites. What were at first taken for young stages of a tick, and referred doubtfully to *Ornithodoros*, have proved to be young and adults of one or two species of Gamasid mites near the genus *Leiognathus*. These were found in abundance, engorged and unengorged, on all vizcachas (*Lagidium peruarum*, Meyer) examined from over 12,000 feet altitude down to well within the known verruga zone of the Rimac valley. On the possibility that these mites may infect through being swallowed, as in the case of *Haemogregarina* (*Hepatozoon*) transmitted by *Laelaps*, a large number of the mites were fed to monkey, rabbit, guinea-pig, dog and fowl. A rabbit and a guinea-pig were exposed to the bites of the mites for 113 and 125 hours respectively at a stretch. Injections of the mites macerated in an artificial serum were given subcutaneously to monkey, rabbit, guinea-pig and dog. The feeding and biting experiments date from the middle of May 1913, and the injection from the first of June. The mites used represented nymph and adult stages and all ages since partaking of a blood-meal, some being completely engorged, some partially engorged, and many wholly free from traces of blood. Temperatures were taken constantly but no notable rises were detected. Blood-smears from the treated animals stained with Giemsa showed nothing abnormal.

The only true tick found on the vizcacha was *Ixodes lagotis*, Gervais. It was secured in the larva, nymph and adult stages. The larva and nymph possess the peculiar inner spine to the first palpal joint, which is lost in the adult, as described by Nuttall and Warburton for *I. angustus*, Neumann, to which the species is evidently allied. Thus this species was originally referred to the right genus, though known to Gervais only in the nymph, and is not a *Haemaphysalis*, as had been supposed by Neumann, Lahille and others. It was not experimented with, partly from lack of sufficient material, and also owing to the fact that, on account of its wide range southward into Chile, it does not offer much promise of being a verruga transmitter.

The native rats of the higher Andean region show abundant infestation with an *Ixodes* sp., but no Argasids have yet been found on them. Various birds are also infested with *Ixodes* spp., one of them appearing allied to *I. auritulus*, Neumann. Larvae of Argasid ticks, probably *Argas* spp., have been taken from goatsuckers and a ground-owl (*Athene* sp.) in the lower part of the verruga zone. An *Ornithodoros* sp., of nocturnal habit, distinct from both *O. talaje*, G. M., and *turicata*, Dugès, but more allied to the latter, occurs in all stages in

mud walls of dwellings in the Peruvian montanya of the Chachapoyas region, but is unknown in the verruga zones. *Ornithodoros talaje*, G. M., occurs on sea-birds along the Peruvian coast and on the guano islands, but no Argasid tick has been taken on mammals in the verruga zone. Thus the outlook for tick work in connection with verruga transmission has seemed less promising than ever as the investigation progressed, taken in conjunction with the negative results of the acarid infection experiments. A recast of the transmission possibilities has therefore become desirable.

At this juncture the writer recalled the repeated reports of biting gnats in the verruga zone that have reached him since the inception of the investigation, but which he had laid aside so far as referring either to *Simulium* spp., or to Chironomids which are prevalent outside the verruga zones. Specimens of biting gnats, reported to be what are known to the natives as *titira*, secured by Dr. A. L. Barton in November last from the verruga zone, proved to be a common Chironomid, not confined to the verruga belts. At Matucana, the writer was told in January of a biting gnat, but the only specimen that could be procured proved to be a Cecidomyid. In March, Mr. Otto Holstein, Chief of Traffic for the Central Railway, stated that biting gnats had entered his car at night while in San Bartolomé and had bitten the inmates, his description indicating a gnat more slender than *Simulium*. It was thought at the time to be a *Ceratopogon* sp., which occurs also at Chosica outside the verruga zone. In April, gnats caught by a native in the writer's presence at the mouth of Verrugas canyon and stated to have been biting, proved to be Borborids. Thus being so far unable to obtain any bona-fide biting gnats in the verruga zones other than *Simulium* and certain common Chironomids that exist elsewhere, and never having passed a night within the permanent limits of the zones, the writer had never been able to gain authentic information of any gnats therein that might be suspected of being confined to these zones. While all bloodsuckers, wherever met, both in and out of the verruga zones, were carefully collected and studied, Culicids, certain species of *Ceratopogon* and other Chironomids, *Simulium*, Tabanids, fleas, bugs, *Stomoxys*, lice and other hexapod bloodsuckers known in the region were confidently excluded from the possibilities of verruga transmission on account of their habits and occurrence outside as well as inside the verruga zones.

Mainly with the possible occurrence of *Phlebotomus* in mind, these reports were now followed up as a promising clue, not only because of the persistence with which they had presented themselves, but also because of the writer's experiences with *Oecacta* and similiar forms in Mexico, and because of a reminder recently in a letter from Dr. Adolpho Lutz that CERATOPOGONINAE and PHLEBOTOMINAE may bite in early evening and enter houses, though not natural frequenters of dwellings. Above all, the recently published results of Marett and Newstead on the *Phlebotomus* flies of the Maltese Islands, in which the early-stage habits and habits of the flies themselves are detailed, indicated that *Phlebotomus* is almost certainly the verruga transmitter, provided it occurs in the region affected, as it well might do.

Accordingly the writer spent the night of 25th June 1913 at San Bartolomé, a noted endemic focus of verruga in the Rimac valley, just below Verrugas

canyon. With a couple of candles set in front of a glass window in the railway station, he caught something over a hundred small gnats between 6.30 and 9.30 pm. He was told that these gnats suck blood and are called *titira* by the natives. None of them attacked him so far as he was aware. Those caught appeared to be CERATOPOGONINAE largely, and on showing them the next morning to a native ranchero the latter stated that the true *titira* possesses white wings and breeds in the hills. This description immediately suggested *Phlebotomus*, but further search seemed to indicate nothing as to the presence of these flies in the region. Verrugas canyon itself, which is considered to be the principal focus of the disease, was explored for five hours by the writer on 25th June, and previously for three hours on 16th April, but without finding anything there further than strictly day-biting insects—*Simulium* and Tabanids. On the first occasion the bed and sides of the canyon had been well dragged with white flannel cloths by the writer and his assistant, Mr. E. W. Rust, for some considerable distance above the famous Verrugas Bridge, but without finding a single tick of any description. At the mouth of the canyon and at San Bartolomé, sleeping quarters and bedding had been carefully examined in April without finding anything other than Culicids and fleas, though at that date a child, inmate of one of these apartments, was seen in the characteristic fever stage of the disease, proved by a magnificent nodular eruption of two weeks standing, when seen again on 25th June. On the latter date an Italian, who had been breaking rock for some weeks in camp between Verrugas canyon and San Bartolomé, was brought into the station building in characteristic condition of anaemia and fever, evidently verruga, as he acknowledged that he had been much bitten by *titira* in the evenings while in camp.

A detailed microscopic study of the gnat material secured, revealed, as more or less pertinent to the investigation, some 40 specimens of a *Ceratopogon* sp. which occurs also at Chosica; about 40 or more of what is probably an *Orthocladius* sp., also occuring at Chosica; a dozen or so of a *Tanytarsus* sp.; and lastly, 2 specimens of a *Phlebotomus* sp., which had been taken with the rest without suspecting their identity! The *Ceratopogon* and *Tanytarsus* appear to possess mouth-parts adapted for bloodsucking, especially the former, but none of them was engorged. A balsam mount of the mouth-parts of the *Orthocladius* indicates the bare possibility of this form sucking blood also. The *Phlebotomus* admits of no question in this regard. The two specimens of the latter, it should be noted, lacked the legs and had evidently been lying dead for some time on the window frame, for all gnats seen, dead or alive, were carefully removed from the window during the collecting. All information obtainable in the district indicated that the *titira* were more abundant at night in the vicinity of Verrugas canyon than at San Bartolomé at this season. The term *titi* is apparently used interchangeably with *titira* for all the extra-culicid biting gnats that appear at night in the verruga zone, but the true *titira* appears to be the *Phlebotomus* sp. without doubt, from its distinctively adapted blood-letting mouth-parts and unquestioned blood-sucking habit. Moreover, it does not occur at Chosica, while the above-mentioned CEROTOPOGONINAE do occur there.

Here at last is probably the true explanation of the observed facts, frequently dwelt upon by Dr. Ernesto Odriozola, to the effect that verruga localities are

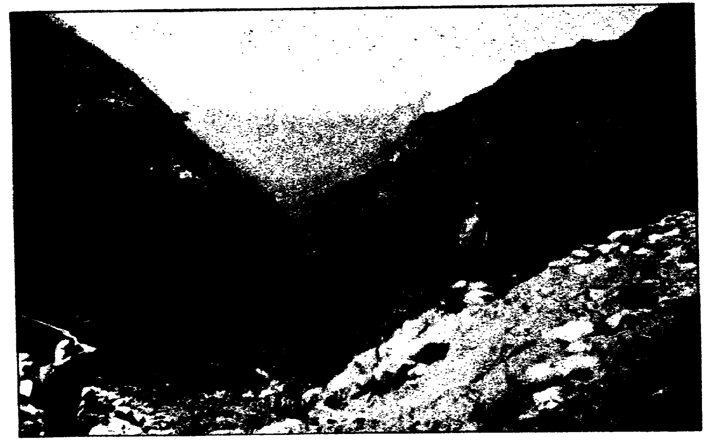
always situated in or near deep narrow canyons, with much vegetation, heat and little ventilation. It is now known that the *Phlebotomus* flies avoid the wind, the sun, and even the full daylight as well. They appear at sunset, if there is no wind, and enter houses, if the light be not to strong within. Candles and oil lamps attract them, but strong electric lights appear to dispel them. During the day these gnats remain hidden largely within the interstices of rock formations, in loose earth, caves, etc., or amongst rank vegetation out of the light and wind. They suck the blood of practically all warm-blooded animals, and have even been known in Africa to suck the blood from a lizard. Thus they are not at all dependent on man, and the primary reservoir of verruga doubtless lies in the native fauna, as already suggested by the writer.

Phlebotomus breeds in caves, recesses in the rocks, even in rock embankments, stone fences and walls, showing interstices however small, and minute recesses in newly excavated rock, gravel and earth material. This explains the *excavation* theory of infection, also the *soil* theory. The fact that the flies never appear till sunset explains why the Central Railway bridge-building gang in 1909 escaped infection as soon as they began to pass the nights in Chosica. The flies are confined to places sheltered from the winds, which explains the peculiar altitudinal distribution of verruga, otherwise to be explained only on the theory of tick or other acarid transmission. The flies doubtless breed most abundantly during periods of moderate humidity. Too much humidity appears to retard their development, as does cold. The winds have little sweep in the narrower, deeper and more tortuous quebradas of the verruga zones, the natural stagnation of the air being especially favourable to the presence of the gnats. The caves and rock conditions necessary to their breeding exist without limit in these canyons, and the vegetation in the bottoms affords them shelter by day or night.

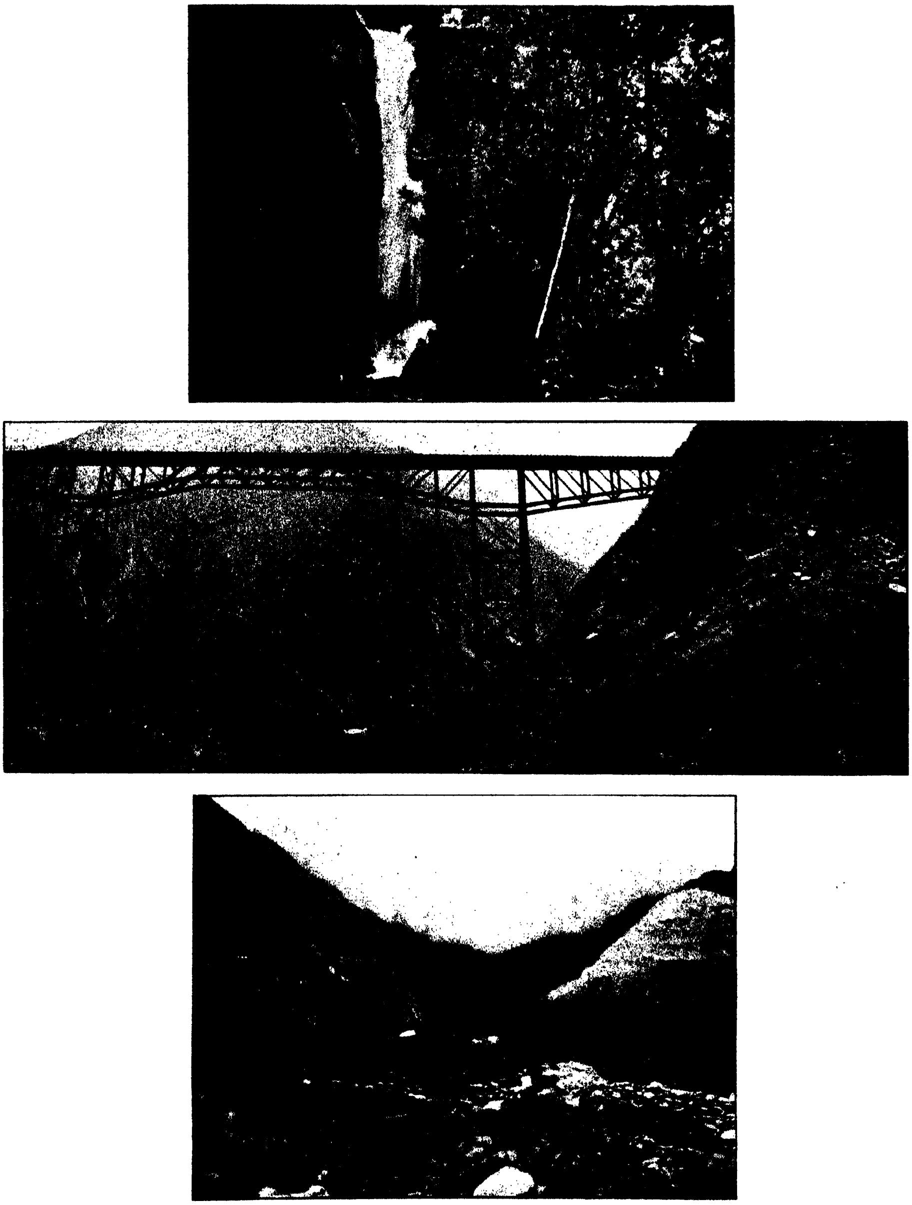
The close parallelism between verruga and Rocky Mountain spotted fever, as detailed by the writer, loses little of its force except that acarids are less indicated in the transmission of the former and the causative organisms of both are probably to be referred to the ultravisible group conveniently termed the Chlamydozoa.

So far it has not been possible to secure sufficient numbers of the *Phlebotomus* for experimentation, the season for them being apparently on the wane, but such work will be started at the earliest possible moment. It is most confidently expected that this work will give prompt and positive results in verruga infection. Theoretically and practically, from all points of view, the connection between this *Phlebotomus* and verruga could not be more perfect than it is, save for the actual demonstration of the transmission. It is practically certain that the *Ceratopogon* and other Chironomids cannot carry the infection. While there is yet time for the acarid transmission experiments to show results, and they will be carried straight through, it now appears certain that *Phlebotomus* is indicated above all others as the agency concerned in the transmission of verruga.

Verruga Laboratory, Chosica, Peru.
29th June, 1913.

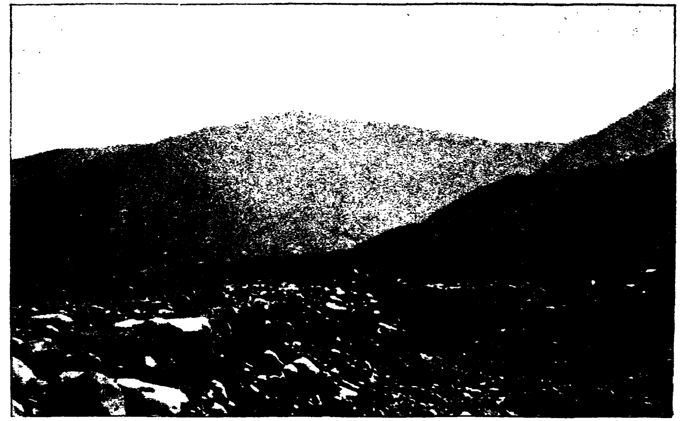


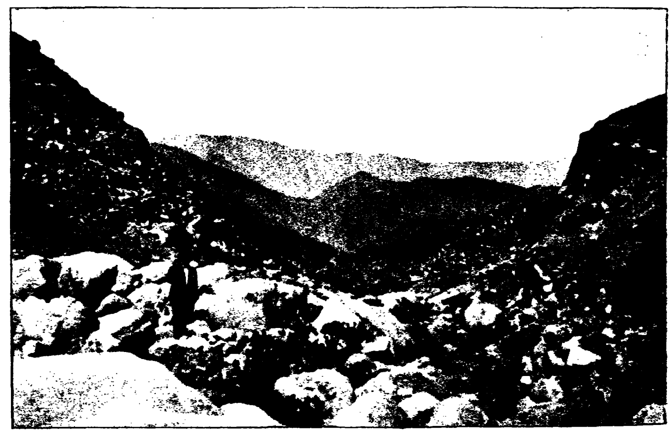
[Photos by Townsend and Rust.



[Photos by Townsend and Rust.

VERRUGAS BRIDGE of the Central Railway across Verrugas Canyon, 5,840 ft., the building of which cost the lives of thousands of workmen by verruga. Lower figure, from mouth of canyon; middle, from up canyon; upper, first waterfall above bridge. April.





THE ANOPHELES OF MALAYA.—PART I.

By A. T. Stanton.

(*Institute for Medical Research, Kuala Lumpur, Federated Malay States.*)

In this series of papers it is proposed to give the results of a detailed study of the individual species of the *Anopheles* mosquitos of the Federated Malay States. The ova, larva and pupa stages of certain species will be described for the first time. Specimens bred from the ova laid by females in captivity will form the basis of this study and by this means it is hoped to avoid those inaccuracies which are liable to result from the absence of such experimental observations.

In a previous paper published in this journal (vol. iii., p. 387) attention was directed to the growth-changes which occur in those characters of *Anopheles* larvae which are believed to be of importance in their specific differentation. In view of the findings there recorded, I shall include under each species a description of the immature stages of the larva, as well as of its mature form.

Some authors lay stress on the specific value of the form of the leaflets in the palmate hairs, whence it might be inferred that the leaflets in all the palmate hairs of a given larva are of similar form. This however is not the case and when reference is made to the form of such leaflets the segment which bears them should be indicated. When palmate hairs are borne on the thorax they are usually different in shape from those borne on the abdominal segments.

The synonymy suggested for the different species is based on the study of a series of specimens, derived in most cases from a single female of the species and on careful comparison of these specimens with published descriptions. It has not been possible to examine all the original types, some of which are now non-existent and others inaccessible to the writer ; it is possible therefore that this synonymy may require revision at the hands of those who have opportunity for this investigation and who are also familiar with the common variations in the species itself.

There is no doubt that in this group of insects the number of species names has been unnecessarily increased by authors attaching exaggerated importance to characters which on further study have proved to be variable, and that the natural affinities of species have been obscured by the division of the group into a multiplicity of genera.

Anopheles tessellatus, Theo.

Anopheles tessellatum, Theobald, Mon. Culic. i, p. 175 (1901).
Anopheles punctulatus, Theobald (*nec* Dönitz), Mon. Culic. i, p. 175 (1901).
Myzomyia tessellatum, Theobald, Mon. Culic. iii, p. 55 (1903).
Anopheles deceptor, Dönitz, Zeit. für Hygiene, xli, p. 60 (1903) ; Theobald, Mon. Culic. iii, p. 105 (1903).
Myzomyia tessellata, Theobald, Mon. Culic. iv, p. 42 (1907).
Myzomyia punctulata, Leicester (*nec* Dönitz), Stud. Inst. Med. Res., F.M.S., iii., pt. 3, p. 27 (1908).

Dactylomyia ceylonica, Newstead and Carter, Ann. Trop. Med. Parasit. vi, p. 377 (1910).

Nyssomyzomyia punctulata, James and Liston (*nec* Dönitz), Anoph. Mosq. India, 2nd ed., p. 104 (1911); James and Stanton, Trans. Far East. Assn. Trop. Med. 1912, p. 315.

The suggested synonymy is based on the following considerations. The species here referred to under the name *tessellatus* was first described by Theobald from specimens taken in Malaya. In his manuscript he gave it the name *Anopheles tessellatum*, but before publication, having seen Dönitz' description of his *Anopheles punctulatus*, he considered the two to be identical and used his description as that of *Anopheles punctulatus*, Dönitz. In a later volume of his monograph (iii, p. 55) Theobald states that, as pointed out by Dönitz, *tessellatus* is distinct from *punctulatus*; the former species he includes in the genus *Myzomyia* and the latter in the genus *Cellia*—to this opinion he adheres in his volumes iii and iv. In volume v I can find no reference to *tessellatus*, but *punctulatus* is again referred to under the genus *Cellia*.

I here accept the view adopted by Theobald and confirmed by Dönitz' subsequent description of a species, *Anopheles deceptor*, which conforms in all respects to that of the Malayan species *tessellatus*, though Dönitz was unable to satisfy himself that such was the case. Examination of perfect newly hatched specimens has shown, however, that Theobald's drawings were not quite accurate in regard to those markings which Dönitz considered to be of specific importance and upon which he relies in the separation of *deceptor* from *tessellatus*.

Newstead and Carter have described from Ceylon an *Anopheles* under the name *Dactylomyia ceylonica*, characterised, according to these authors, by "a distinct and very pronounced cylindrical-shaped tubercle or finger-like process projecting obliquely from the prothoracic region." Where the tuft of scales on the shoulder is absent, as appears to have been the case in the partially denuded specimen examined by Newstead and Carter, the prothoracic lobes are conspicuous objects. The appearance of a finger-like process projecting from the prothoracic region is, I believe, the effect of drying with partial displacement of the prothoracic lobes—it occurs in many well-known species and is sometimes unilateral. In all points noted in the description of *Dactylomyia ceylonica* the species appears to be identical with Malayan *tessellatus*, and Newstead and Carter's excellent description and illustrations of their specimen leave no reasonable doubt that *ceylonica* and *tessellatus* are the same species.

Doubtless owing to the confusion which had arisen in regard to Dönitz' *punctulatus*, James and Liston in their last edition redescribed Indian specimens, considered to belong to that species, under the name *Nyssomyzomyia punctulata*, James and Liston. This species is however identical with the Malayan *tessellatus*, and though I sympathise with these authors in their attempt thus to cut the Gordian knot, I think their name also must sink as a synonym of that species.

From the ova laid by a female *Anopheles tessellatus* in captivity, larvae and pupae in due course developed and finally adult mosquitos. From the deposition of the ova till the emerging of the imagines periods varying from seventeen to twenty-eight days elapsed.

The Ovum (fig. 1).

The upper surface is narrow and the floats do not touch its margin (type 1 of Christophers). The narrow striated frill is continuous around the whole of the margin of the upper surface. The thin membrane which covers the under

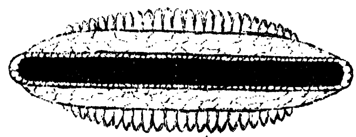


Fig. 1.—Egg of *Anopheles tessellatus*, Theo.

surface of the ovum, except over the area occupied by the floats, has a reticulated pattern. The floats are oblong in shape and extend over the middle two-thirds of the length of the ovum; each float has about twenty corrugations. Length of ovum, 0·45 mm.

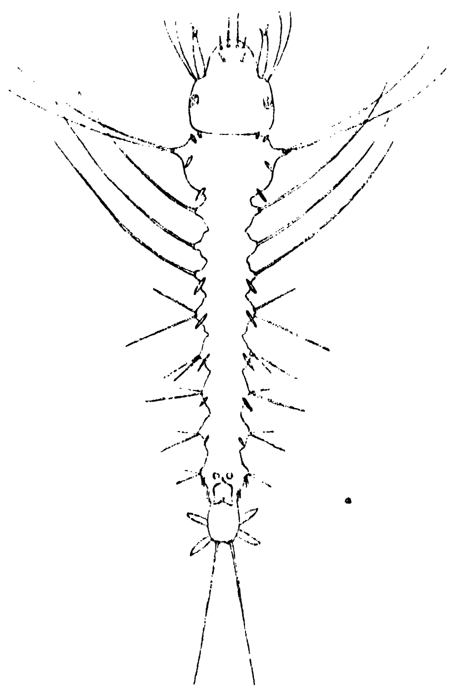


Fig. 2.—Newly hatched larva of *Anopheles tessellatus*, Theo.

The Newly Hatched Larva (fig. 2).

Head. The inner anterior clypeal hair is long and stout; the outer clypeal hair is very short, only about one-sixth the length of the inner; the posterior clypeal hair is placed far back, midway between the anterior clypeal hairs and the row of frontal hairs. As in most newly hatched *Anopheles* larvae, all the

clypeal hairs are simple. *Thorax.* On the thorax are borne four pairs of simple leaflets, precursors of the stout feathered hairs and palmate hairs of the more mature forms. *Abdomen.* Simple leaflets are borne on the third to seventh segments inclusive, that on the seventh being much smaller than the others.

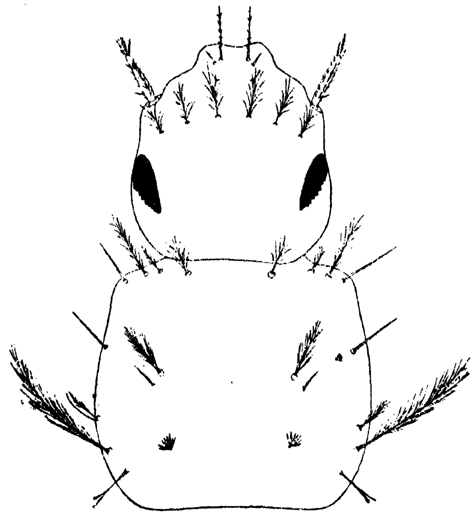


Fig. 3.—Head and thorax of mature larva of *Anopheles tessellatus.*

The Mature Larva (fig. 3).

Head. The inner anterior clypeal hairs are placed about one-third the breadth of the head apart, they are long and stout and with the higher powers of the microscope are seen to be finely pinnate (fig. 4*a*); the outer clypeal hair is short, only about one-fifth the length of the inner and is seen with difficulty

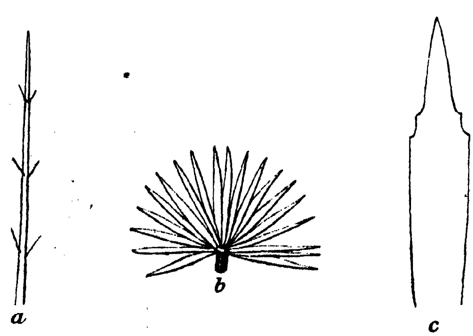


Fig. 4.—Larva of *Anopheles tessellatus*, Theo.; (*a*) inner anterior clypeal hair; (*b*) palmate hair of sixth abdominal segment; (*c*) leaflet of the same palmate hair.

in the living larva—it is a simple hair; the posterior hair is placed far back and is simple. The body of the antenna is thickly beset with small spines and carries a tiny simple spicule on its antero-lateral aspect, about one-third of

the length from the base; the basal hair is branched. *Thorax.* In addition to the usual stout feathered hairs and bristles, the dorsum of the thorax carries a pair of palmate hairs, each whorl being composed of seven narrow lanceolate leaflets. *Abdomen.* Palmate hairs are borne on the third, fourth, fifth, sixth and seventh segments; on the first four of these segments the leaflets are broad (figs. 4*b* and *c*); the average total length of the leaflets on the mid abdominal segments is 0·055 mm.; the average relation of the filament to total length of filament and body of leaflet is as 1 is to 4; the indentations at the base of the filament are minute; on the seventh segment the leaflets are narrowly lanceolate. The spiracle comb usually carries four large and six small spine-like processes, none of which are toothed.

Among Malayan species the mature larva of *Anopheles tessellatus* most nearly resembles that of *Anopheles kochi.* Both are peculiar in the extreme shortness of the outer anterior clypeal hair, but the inner anterior clypeal hairs are placed farther apart in *kochi* than in *tessellatus*, and *kochi* carries a pair of palmate hairs on the second abdominal segment which *tessellatus* does not.

The Pupa.

The pupa of this species is without any distinguishing feature. The first abdominal segment carries the usual pair of fan-like tufts of branched hairs. Small lateral spines are present on the fourth to seventh segments.

I am indebted to my colleague, Mr. R. W. Blair, for the drawings accompanying this paper.

THE MYZORHYNCHUS GROUP OF ANOPHELINE MOSQUITOS IN MALAYA.

By C. Strickland, M.A., B.C., Cantab.,

Travelling Medical Entomologist, Federated Malay States.

The object of the present paper is to make some remarks about certain of the species and genera mentioned in Leicester's 'Monograph of the Culicidae of Malaya' (1908), together with certain related species described by other authors. I have paid special attention to Leicester's work because it remains the standard book of reference on the mosquitos of Malaya.

The species that will be dealt with are the following:—*asiatica*, *sinensis*, *annularis*, *minutus*, *vanus*, *barbirostris*, *umbrosus*, *paeditaeniatus*, *separatus* and *albotaeniatus*, which have all been mentioned by one author or another as coming from Malaya. The genera which I propose to discuss are *Myzorhynchus*, *Lophoscelomyia*, and *Patagiamyia*.

The Validity of the Species.*

The validity of *asiatica*, *barbirostris*, *umbrosus*, and *sinensis* is not disputed; but concerning the others there has been some doubt and a review of the subject seems desirable.

I. *Paeditaeniatus*, Leicester (1908). Concerning this species it must be remarked that its sponsor, after weighing all the evidence, dismissed the doubt that it was not a distinct species from *sinensis*: he said, "The larvae differ constantly from those of *M. sinensis*. In the larva of *M. sinensis* each frontal hair consists of a short thick stem supporting numerous stiff bristle-like hairs, in *M. peditaeniatus* it is formed by a long thin stem which splits into a few, five or six, fine hairs"; and of the adult fly he said, "The wing scaling also differs from that of *M. sinensis*, as it is much darker and the contrast of the two colours is more pronounced, and the lateral scales are broader. The posterior cross-vein is much nearer the median in *M. sinensis* than in this mosquito"; and again, "In *sinensis* the yellow scaling of the wing predominates and the brown scales are more or less collected into small spots, while it is exactly the reverse in *peditaeniatus*."

Now these are definite enough arguments, yet James and Stanton (1911) do not answer them, but on the ground that the leg-banding of *sinensis* (sensu Leicesteri) is very variable and that therefore the broad leg-bands of *paeditaeniatus* might be an extreme form of the leg-bands of *sinensis*, they reject *paeditaeniatus* as a distinct Malay species. If only the fly itself had been concerned Leicester himself would have probably called it *sinensis*, for he said, "The real reason for separating them is the differences in the larvae." I agree; for although the distinctive wing-marking of *paeditaeniatus* and *sinensis* mentioned above, which is given by Leicester, is certainly often seen, yet every intermediate type

---

* The validity of the species is here considered on morphological grounds only.

can be found. In one undoubted *paeditaeniatus* in my possession the wing-marking was even the exact reverse of Leicester's description, the wing-scaling being largely yellow with brown spots; and I have often seen *sinensis* with the scaling of the wings very largely brown. The position of the cross-veins is quite as variable also. The broad golden leg-bands of *paeditaeniatus* are again, as James and Stanton also say, connected by every type of intermediate form with those of *sinensis*. The costal spots are the same in both species, and the apical fringe spot varies from a size similar to what it is in *umbrosus* to a broad band visible to the naked eye, and this is not correlated at all with the amount of leg-banding. We must therefore conclude that on morphological grounds it is impossible to say that *paeditaeniatus*, *if the imago only is considered*, is a distinct species.

We are then confronted by the difficulty that although the imagines of the two species run into one another, yet only two types of larvae are known, according to Leicester, one of which produces his *paeditaeniatus* fly and one his *sinensis*.

Now if these larvae are really distinct and no intermediate forms exist between them, it is enough reason to establish the validity of two species, even though the imagines cannot be distinguished. But I surmise the as yet undiscovered existence of larval intermediate forms which perhaps produce the fly intermediate forms which Leicester has not described.

Leicester's observation at any rate shows an interesting correlation between larval and imaginal structure of extreme forms within a species. If he had not stated that this correlation of structure was constant, we might have explained his observation as illustrating the larval variability which Stanton (1911) has found, but weighing all the evidence, I think that we are justified in assuming that *paeditaeniatus* is the same species as *sinensis*.

II. *Annularis*, Wulp (1884). It is perhaps unnecessary to mention this species, as it has been generally regarded as synonymous with *vanus*.

III. *Vanus*, Walk. (1860). This species appears in Theobald (1903 and subsequently), but no writer on Malayan Anophelines has mentioned it. Forms corresponding to Theobald's description certainly occur, but they are not distinct from *sinensis*, being connected by every possible intermediate form, and the species must therefore be sunk.

IV. *Minutus*, Theo. (1903). The same remarks apply to this species as to *vanus*, and it cannot therefore stand as a distinct species.

V. *Albotaeniatus*, Theo. (1903). Theobald, Leicester, and Alcock, all give this as a distinct species, but James and Stanton, after saying they have not seen it, do not give it a place in their list of Malayan Anophelines. However, it is perfectly distinct, and I have never seen intermediate forms between it and *umbrosus*, its nearest relative. Besides myself, Dr. Watson of Klang, F.M.S., has seen it on several occasions.

VI. *Separatus*, Leic. (1908). Leicester gave definite reasons why he thought this a distinct species from *sinensis*. He said "The points of distinction seem constant, the brown mesonotum, white apical palpal joint, and predominant yellow scaling distinguish it." James and Stanton later endorsed this view, but Leicester's reasons, as a matter of fact, are not very satisfactory, for the points of distinction from *sinensis* given by him seem to be rather points of resemblance to his own description of *sinensis*; although in another place he says, "This

mosquito has no ventral scale-tuft, which is one of the marked characteristics of members of this genus, including *sinensis*." Certainly *sinensis* (*sensu restricto*) has also a brown mesonotum, white apical palpal segment, and predominant yellow wing-scaling, so the only point of difference apparently remaining is the ventral scale-tuft. Now, concerning this, it is true that forms without any ventral scale-tuft are very common, but forms with every intermediate type of structure between them and *sinensis* exist, and I therefore think that *separatus* is not a distinct species from *sinensis*. If it is, I do not know where the line can be drawn in practice. Leicester himself said that it might be a variety of *sinensis*; but I do not think that a collection of forms connected with a species by a whole series of intermediate types should be even called a *variety* of the species, which implies a distinct group. The scaling of the last segment of the abdomen is not important specifically. I have seen undoubted *sinensis* (*sensu restricto*) with, or without, scales on the dorsum also of the last segment, and also specimens bred out from the same pond and killed immediately, one with a heavy ventral tuft, one with only a few scales in the tuft, and one with no tuft at all. There could be no question of the tuft having been rubbed off, for the specimens were in a perfect condition otherwise,* and these forms with only a few scales in the ventral tuft are common enough.

In fact, it only needs a month or two's work with so-called *sinensis*, *annularis*, *vanus*, *paeditaeniatus*, *separatus*, and *minutus*, to prove that it is impossible to separate them up into morphological groups. I therefore recognise only the following as valid species† :—*barbirostris*, *sinensis*, *umbrosus*, *asiatica*, and *albotaeniatus*.

The Generic Grouping.

With regard to the generic grouping of the five species which we have considered valid, it must be remarked that Leicester (1908) named *asiatica* a *Lophoscelomyia*, and referred the other four species, *sinensis*, *barbirostris*, *umbrosus*, and *albotaeniatus*, to *Myzorhynchus*. However James and Stanton (1911) placed *umbrosus* in the genus *Patagiamyia*, this genus having been created by James and Liston for species such as *umbrosus* and *albotaeniatus* which have patagial tufts, but have no ventral tuft on the eighth abdominal segment. It may certainly be possible that a distinct group exists in India of these mosquitos, but in Malaya these are united to the forms known to James and Liston as *Myzorhynchus* (which *have* a ventral abdominal tuft) by a whole series of annectant forms. For example:—

(1) *sinensis* is represented here by specimens which have or have not the ventral abdominal tuft;

(2) *barbirostris* has likewise occasionally forms with or without an abdominal tuft;

* I have had a *barbirostris* with no ventral tuft on the eighth segment, but with small tufts on the other segments.

† A new species, which I have not seen, has just been described in the Journal of the London School of Tropical Medicine.

(3) *umbrosus* has sometimes its last abdominal segment clad with scales, and it is therefore not improbable that occasionally these take the form of an outstanding tuft;
(4) *barbirostris* has sometimes a series of ventral tufts, a fact indicating that the presence or not of such scales is not of much importance phylogenetically;
(5) the females only are ever tufted, the males cannot be grouped into genera morphologically except by reason of their relationship to the females.

In short, species which are placed by James and Stanton (1911) into two genera have forms in Malaya which run into one another, and it is impossible to distinguish two distinct groups of them.

Similarly we have evidence that the genus *Lophoscelomyia* is the same as *Myzorhynchus*. Alcock (1911) came to the conclusion that this was so, and referred *asiatica* to his subgenus *Myzorhynchus*. Now *Lophoscelomyia* is distinguished from *Myzorhynchus* by the presence on the femora of the outstanding tuft of scales in the former which is absent in the latter, as well as scales on the dorsum of the last abdominal segment, supposed to be absent in *Myzorhynchus*. But—
(1) I have found a *barbirostris* with tufted femora as in *asiatica*;
(2) I have found specimens of *umbrosus* and *barbirostris* with the last abdominal segment clad with flat scales, which is one of the main points of the genus *Lophoscelomyia*;
(3) the wings of all the species placed in *Lophoscelomyia* or *Myzorhynchus* are marked in a strikingly similar manner; thus the costa has nearly always two golden spots or rudimentary spots, one at the junction with the subcostal and one at the junction with the first longitudinal vein; the first of these nearly always involves the first longitudinal, while the second nearly always involves the upper branch of the second longitudinal; the lower branch of the second longitudinal has also nearly always an area of light-coloured scales and the wing-fringe has always a golden spot opposite the junction of the third long vein; and
(4) *Lophoscelomyia* has patagial tufts like *Myzorhynchus*, and its clothing of hairs and scales is essentially similiar.

I conclude therefore with Colonel Alcock that *Lophoscelomyia* is not distinct from *Myzorhynchus*, and that the five species *sinensis*, *barbirostris*, *umbrosus*, *albotaeniatus*, and *asiatica* form generically one group.

I note that Colonel Alcock on the other hand would not divide up the Anophelines into groups at all, but would call them all *Anopheles*. But the species here discussed form such a well-defined group that I think myself that it would be 'defeating the humane objects of a natural classification' not to knit together under a separate title obviously related forms such as these, and I therefore suggest that the genus *Myzorhynchus* do stand.

The Morphology of the Species.

In the descriptions which follow, the imagines only are concerned, as the morphology of the other stages has not been considered, and the plan adopted

will be to give, after making a few preliminary remarks, (1) a 'definition' of the species in as simple terms as possible, which will be exclusive (in Malaya) for the species under discussion; (2) the general naked-eye appearance; and finally (3) the complete revised description.

Myzorhynchus sinensis, Wied.

Remarks. The wing marking has no specific character except the two costal spots and the apical fringe spot; the abdominal ventral tuft is not a specific character.

Definition. Mosquito with banded palps and not more than two costal spots.

Naked-eye appearance. Dark brownish black mosquito without obviously dappled wings; its palps not half as wide as the head.

Description. Head: on the vertex a tuft of long white scales projecting forward, on the occiput a patch of bluish white upright scales, on the nape and cheek dark brown upright scales. Palpi with four narrow bluish white bands. Proboscis all black. *Thorax* clad with long golden hairs; patagia with a dense cockade of palisade scales. *Wings* clad with dark chocolate-brown, golden and creamy scales; the costa with brown scales broken by two golden spots, one where the subcostal vein joins the costal, and one where the first longitudinal meets the apex; the wing-fringe golden at a spot at the apex. *Legs* dark brown, except for golden banding at the articulations; the extremity of the fifth tarsal segment dark brown. *Abdomen* dark brown, clad with long golden hairs.

Myzorhynchus barbirostris, van der Wulp.

Remarks. I have found this species without a white spot in the wing-fringe opposite the lower branch of the fifth long vein, so it can no longer be considered that this character is specific. I have also found specimens without a ventral abdominal tuft on the eighth segment, and it is almost certain that the tuft in these specimens had not been rubbed off, because on each of the other abdominal segments there was a small undamaged tuft of black scales. I thought at first that these represented a new species, but the large black shaggy palps, and the white spot on the wing-fringe, so common in this species, could not be disregarded.

Definition. Mosquito with black palps, more than half the width of the head at their base.

Naked-eye appearance. A black mosquito with very heavy mouthparts. Wings not dappled.

Description. Head: tuft of long scales projecting forward from the vertex, behind this a few dirty white upright scales, and the rest of the head with black upright scales. Palpi all black, clad with scales which are particularly long at the base and can usually be seen discrete. Proboscis black-scaled. *Thorax:* prothoracic lobes with a cockade of black palisade scales; mesonotum clad with pale hairs, a tuft of long narrow white scales projecting over the neck, and a tuft of black scales on each shoulder over the patagia. *Wings* clad with black scales, with yellowish scales mostly over the posterior veins; the costa with two golden spots, one where the subcostal vein joins it, the other where the first longitudinal

joins the latter, involving also the upper branch of the second long vein; the fringe with a small golden spot at the apex, at the junction of the third vein. *Legs* very narrowly banded at the articulations; fifth tarsal segments black. *Abdomen* black, with dark hairs.

Myzorhynchus umbrosus, Theo.

Remarks. Dr. Watson, of Klang, has found a variety of this species characterised by two costal spots, but the examination of a large number of specimens of the typical form and of the variety has shewn that the two types are united by annectant forms. The asserted absence of all scales on the abdomen is not a specific character, for I have seen specimens with the last abdominal segment covered with black scales on the dorsum.

Definition. Mosquito with black palps less than half the width of the head and with the last tarsal segment of the hind leg black.

Naked-eye appearance. A blue-black mosquito without obviously banded legs, and the mouth-parts not heavy in appearance. Wings not dappled.

Description. Head: a tuft of long white scales projecting forward over the clypeus from the vertex, behind this a triangular patch of bluish white scales, and elsewhere clad with dark brown upright scales. Palpi and proboscis all black. *Thorax:* prothoracic lobes with a large cockade of clavate scales; mesonotum clad with pale golden hairs, a tuft of fine white scales anteriorly, and below each shoulder a tuft of dark brown curved scales. *Wings* with a spot on the costa at the junction with the first long vein; wing-fringe with a small yellow spot at the apex, otherwise black. *Legs* minutely banded at the articulations. *Abdomen* black, with pale hairs.

Myzorhynchus albotaeniatus, Theo.

Remarks. Leicester's specimens were described as having the fifth tarsal segment of the hind leg black at the apex; the specimens which I have seen have been entirely white at that place. Another point is that the latter have all had an apical wing-fringe spot, which appears to have been absent in Leicester's examples.

Definition. Mosquito with black palps, and the hind legs very broadly banded with white.

Naked-eye appearance. A bluish black mosquito, without dappled wings and with the hind legs obviously banded with white.

Description. Head with a tuft of golden hairs and hair-like scales projecting forward from the vertex, on the occiput a few white upright scales, and on the rest dark brownish black upright scales. Palps and proboscis black-scaled. *Thorax:* patagia with a tuft of dark brown scales on their apices; mesonotum clad with golden hairs. *Wings* with two costal spots, one small one at the junction of the subcostal vein with the costal, and one at the junction of the first long vein at the apex, which also involves the upper branch of the second long vein. *Legs:* fore and mid legs narrowly banded, hind legs broadly banded with white, the remainder being black; the banding is complete on the last tarsal segment and extends on to the penultimate segment distally for a third of its length, the next three joints being marked by a broad band which extends on to the segments on each side of the joint. *Abdomen* black, clad with pale hairs.

Myzorhynchus asiaticus, Theo.

Definition. Mosquito with the apex of the hind femur clad with a tuft of long outstanding black scales, succeeded by a tuft of long white ones.

Naked-eye appearance. The tuft of scales on the femora of this mosquito can easily be seen with the naked eye.

Description. *Head* with a tuft of long white scales projecting forward from the vertex over the clypeus, behind this a patch of whitish upright scales, and on the occiput dark brownish black upright scales. Palpi clad with black scales, except for a few pale ones at the junction of the third and fourth segments. Proboscis black with light-coloured labellae. *Thorax* : prothoracic lobes with a dense tuft of dark curved scales ; mesonotum with a tuft of white curved scales projecting forward from the promontory, otherwise covered with sparse golden hairs. *Wings* : costa with two spots, the first at the junction of the subcostal vein, the second at the junction of the first longitudinal, which also involves the upper branch of the second longitudinal ; fringe all black, except for a small yellow spot opposite the junction of the third long vein. *Legs* : middle pair with a patch of white scales on the apex of the femur, hind legs having at the apex of the femur a dense tuft of outstanding black scales succeeded by a tuft of white scales. *Abdomen* greenish brown, clad with numerous golden hairs.

Summary.

The following is a summary of the conclusions arrived at in the foregoing paper :—

(1) the species *sinensis*, *barbirostris*, *umbrosus*, *albotaeniatus* and *asiatica* have been considered valid ;

(2) the species *vanus*, *annularis*, *minutus*, *paeditaeniatus* and *separatus* have been rejected as invalid ;

(3) certain new characters of the valid species have been noticed ;

(4) the descriptions of the species have been revised ;

(5) the genus *Patagiamyia* has been rejected, as also the genus *Lophoscelomyia*, both having been included in the genus *Myzorhynchus* ;

(6) it is suggested that the *Myzorhynchus* group forms a series sufficiently distinct from other Anophelines to make it advisable to give it a separate generic title.

References.

Leicester. 'The Culicidae of Malaya.'—Studies from Institute for Medical Research (1908). Kelly Walsh, Singapore.

James and Stanton. Hong Kong Medical Congress Reports (1911).

James and Liston. 'The Anopheline Mosquitoes of India.' Thacker, Spink & Co., Calcutta.

Postscript.

Since writing the above I have received a paper by Dr. A. T. Stanton (' The *Anopheles* Mosquitoes of Malaya, etc.'—Jl. London Sch. Trop. Med. ii, 1913, p. 1) which bears directly in several points on the subject reviewed.

With regard to the validity of certain species, Stanton says anent *separatus* that he has been unable to satisfy himself that it is distinct from *sinensis*, and he has retained *albotaeniatus* for the present, pending the examination of more material. I hope however that I have given enough reasons above to shew for certain that *separatus* is not distinct from *sinensis* and that *albotaeniatus* is certainly a distinct species. He rejects *paeditaeniatus*, *annularis*, *vanus*, and *minutus* as I have also done.

Some points in the descriptions of the species are noted, *viz.*, that *umbrosus* has one *or* two spots on the costa, and that *barbirostris* has a series of small white abdominal ventral tufts ; points with which I agree.

He will not discuss any generic grouping of the species, but names them all *Anopheles*, following Alcock ; I think however that the species mentioned form a group quite well defined from other Anophelines and that we are justified in naming it accordingly as a distinct genus.

A NEW FROGHOPPER FROM TOBAGO.

By J. C. Kershaw.

Tomaspis carmodyi, sp. nov.

Very near *T. saccharina*, Distant. The general ground-colour is, however, darker—nearly black. The ochreous costal marking of the tegmen forming, when both tegmina are closed, an inverted V-shaped marking, is almost obsolete in *T. carmodyi*. The other ochreous markings on the tegmina are rather smaller and sharper in outline than in *T. saccharina*. The chief difference is in the harpes of the genital styles, which are longer, sharper and bent outwards in *T. carmodyi*. *Length*, ♂ 7–7·5 mm., ♀ 7·5–8 mm.

Hab. Island of Tobago, B.W.I.; on grass.

A sketch of the genital styles of *T. saccharina* and *T. carmodyi* appeared in a Circular of the Board of Agriculture, Trinidad, March 1913.

A BUG ATTACKING SESAMUM INDICUM, L.

By W. L. Distant.

Phricodus hystrix, Germar.

Aradus hystrix, Germ., in Silb. Rev. ent. v, p. 134 (1837).

Phricodus hystrix, Spin., Mag. Zool. 1840, pl. 40.; Sign., Ann. Soc. Ent. Fr. (2) vii, p. 327, pl. ix, fig. 111. (1849).

Stenotoma desjardinsii, Westw., Trans. Ent. Soc. 1847, pl. 18, fig. 6.

Phricodus fasciatus, Sign., Ann. Soc. Ent. Fr. (3) viii, p. 924 (1861).

Phricodus hystrix, Germ., is a Pentatomid bug found in South and Central Africa, Madagascar and Mauritius, though in a large collection from the Seychelles which I recently worked out, the species was not included. Mr. T. Bainbrigge Fletcher has just sent me specimens for identification from Coimbatore, S. India, and states that—"It is fairly common here at light and has also been found on Gingelly plants." In all the large collections from India which have passed through my hands in preparing the Rhynchotal portion of the "Fauna of British India" this species was absent, and it is probably of recent introduction in Coimbatore.

The Gingelly plant on which it was found is an oil-plant (*Sesamum indicum*, Linn.) and is distributed all over Tropical Africa, so that the insect will probably be found infesting the leaves of that plant in Africa as well as in India.

NOTES ON A FEW PHOTOGRAPHS ILLUSTRATING THE HAUNTS AND HABITS OF GLOSSINA TACHINOIDES IN BORNU, NORTHERN NIGERIA.

By Dr. Bernard Moiser, W.A.M.S.

(Plates XIII—XVII.)

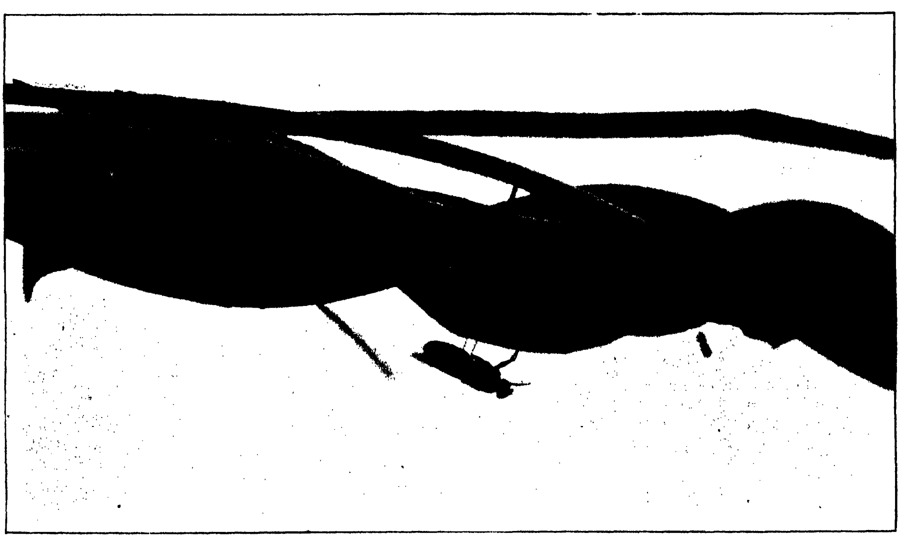
During a residence of a little more than two years (two tours) in Bornu, Northern Nigeria, I have investigated the haunts of tsetse-flies there, whenever an opportunity has occurred, and I find that these flies (*G. tachinoides* is, so far as I know, the only species occurring there, though one specimen of *G. morsitans* was captured in one place) are confined to small patches of dense jungle situated along the course of small rivers. I have now come to know well the kind of "bush" where I can expect to find the flies, and the places where it is useless to look for them. They are found in quite localised areas, in close proximity to rivers or marshes, where there is water all the year round, and where the ground is covered with tall shady trees, mostly tamarinds, and thick undergrowth of thorns and creepers, with some ebony trees.

I do not mean to say that every patch of bush having these characters will be found to harbour the flies, for I have examined many such places without finding them. But the possibility that the ebony trees are in some way a factor determining the presence of the flies has often forced itself on my attention, for they are invariably to be found in the "belts," and I have never found the flies in any locality devoid of them. It is true that these trees are not the only kind common to all the belts, but, whilst engaged in discovering the natural resting place of the flies, I noticed that they were most frequently seen resting on the under side of small ebony shoots close to the ground. These ground shoots have small horizontal branches, devoid of leaves except at the tip, and it is on the under side of these horizontal twigs (as well as on little horizontal thorn twigs) that the flies come to rest. Also, in one experiment, I observed a fly trying to insert its proboscis between the bark and wood of a broken ebony twig.

Two of the photographs (Plate xiii) show living specimens of *G. tachinoides* in such a position of rest. These were obtained in a small "belt" at Bellaram, near Geidam, previously described (Bull. Ent. Res. iii, 1912, p. 195), the characteristics of which are shown in the accompanying photographs.

Another noticeable feature of all the belts I have examined is the large number of warthogs to be found in and around them, but whether these animals have anything to do with the occurrence of *Glossina tachinoides*, I cannot at present say.

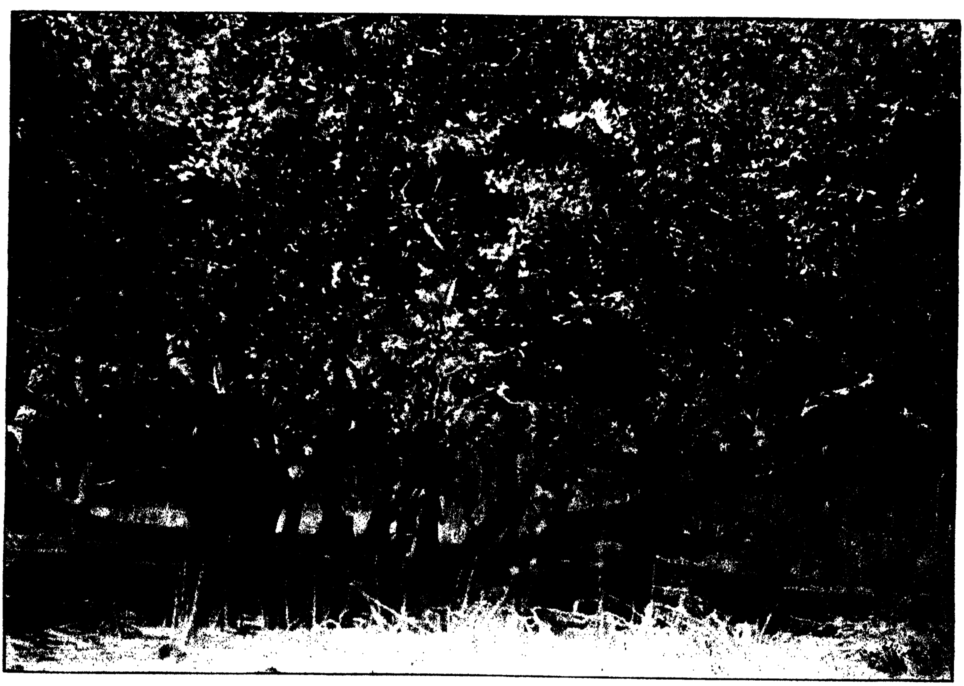
In a future experiment, I intend to cut down the ebony trees only in a belt, and see if this will affect the presence of the flies. A previous article described (*loc. cit.*) how the complete disappearance of the flies was brought about by clearing the whole of the undergrowth, leaving the tall shady trees standing.



Specimens of *Glossina tachinoides* photographed in the natural position of rest.

Views in the *tachinoides* fly-belt at Bellaram, near Geidam, Bornu, showing the general nature of the vegetation and the dense thorny undergrowth.

A Tamarind, the commonest of the larger trees in the Bellaram fly-belt.



Ebony trees, the most characteristic feature of the fly-belt; the surrounding scrub has been cleared.

Portions of the Bellaram fly-belt, showing the effect of clearing and burning the undergrowth.

The River Wobe, which flows in close proximity to the Bellaram fly-belt.

A view over the open Wobe valley from the edge of the belt.

COLLECTIONS RECEIVED.

The thanks of the Imperial Bureau of Entomology are due to the following gentlemen, who have kindly presented collections of insects (received between 1st January and 31st March, 1913):—

Dr. W. M. Aders:—129 Tabanidae, 1 Hippoboscid, 4 Oestrid larvae, 73 other Diptera, 31 Coleoptera, 53 Hymenoptera, 14 Lepidoptera, 4 Anoplura, 25 Cimicidae, 80 Aphididae, 27 other Rhynchota, and 3 Orthoptera; from Zanzibar.

Dr. C. H. Allan, W.A.M.S.:—39 *Tabanus* and 1 *Glossina fusca*; from Sierra Leone.

Mr. R. J. Anderson:—3 *Tabanus*, 2 *Glossina*, 3 Coleoptera, and 2 Rhynchota; from Boonso, Gold Coast.

Dr. H. E. Arbuckle, W.A.M.S.:—11 Culicidae, 44 *Tabanus*, 1 *Stomoxys nigra*, 21 other Diptera, 3 Coleoptera, 3 Hymenoptera, 2 Planipennia, 5 Rhynchota, and one Orthopteron; from Sierra Leone.

Mr. E. Ballard, Government Entomologist:—8 *Simulium*, 1 *Tabanus*, 1 *Stygeromyia*, 8 Tachinidae, 30 Coleoptera, and 1 Ichneumonid; from Zomba, Nyasaland.

Mr. S. Bhagwat:—1 larva of *Cordylobia*; from Uganda.

Dr. C. W. S. Boggs, W.A.M.S.:—1 *Tabanus subangustus*, 30 *Glossina*, 1 *Stomoxys calcitrans*, 1 *Hippobosca maculata*, and 1 Cicada; from Ashanti.

Mr. G. E. Bodkin, Government Economic Biologist:—2 *Chrysops costata*, 10 *Tabanus*, 30 other Diptera, 56 Coleoptera, and 4 Rhynchota; from British Guiana.

Mr. John R. Bovell, Superintendent of Agriculture:—9 Coccinellid beetles and 3 larvae, 2 Cossid moths, and 6 species of Coccidae; from Barbados.

Surg-.General Sir David Bruce, C.B. F.R.S:—78 *Ceratopogon* and 11 other Diptera; from Nyasaland.

Dr. R. Bury, M.O.:—187 Culicidae, 2 *Tabanus*, and 2 other Diptera; from Fort Johnston, Nyasaland.

Mr. D'Emmerez de Charmoy, Government Entomologist:—4 Melolonthid Beetles infesting sugar-cane; from Mauritius.

Dr. Andrew Connal, W.A.M.S.:—34 Culicidae, 115 Culicid larvae, 1 Cimicid bug, and 27 Siphonaptera; from Accra, Gold Coast.

Dr. J. Currie, W.A.M.S.:—20 Coleoptera; from Ibadan, Southern Nigeria.

Mr. C. M. Dobbs, District Commissioner:—9 Culicidae, 8 *Stomoxys*, 2 *Auchmeromyia*, 62 other Diptera, 40 Coleoptera, 39 Hymenoptera, 1 Moth, 1 *Chrysopa*, 8 Orthoptera, 35 Rhynchota, 1 Dragonfly, and 1 Tick; from Kericho, British East Africa.

Dr. D. Drew, M.O.:—4 Culicidae, 2 *Tabanus*, 27 *Glossina*, 1 *Auchmeromyia*, and 4 Bombyliidae; from South Nyasa, Nyasaland.

Dr. R. Drummond, M.O. :—1 *Haematopota mactans*, 3 *Tabanus*, 108 *Glossina morsitans*, and 120 other Diptera ; from Nyasaland.

Dr. H. Lyndhurst Duke, Tempy. M.O. :—5 *Tabanus* ; from Uganda.

Mr. Geo. W. Evans, Department of Agriculture :—A number of Coccidae ; from British East Africa.

Mr. T. V. Fox, Assistant District Commissioner :—3 *Tabanus thoracinus* and 111 *Glossina* ; from Acholi District, Uganda.

Mr. Claude Fuller, Provincial Entomologist :—14 Moths and 18 Jassid bugs ; from Pretoria, Union of South Africa.

Dr. Lewis H. Gough, Government Entomologist :— 6 Lepidoptera, 2 Ichneumonidae, and 6 Braconidae ; from Egypt.

Mr. C. C. Gowdey, Government Entomologist :—271 Diptera, 11 Siphonaptera, 828 Coleoptera, 539 Hymenoptera, 34 Lepidoptera, 7 Myrmeleonid larvae, 616 Orthoptera, a number of Coccidae, 889 other Rhynchota, and 13 Ticks ; from Uganda.

Mr. P. Lechmere Guppy, Board of Agriculture, B.W.I. :—Parasitic Hymenoptera (Mymaridae and Chalcididae) ; from Trinidad.

Dr. H. F. Hamilton, W.A.M.S. :—195 Culicidae, 2 *Tabanus*, 8 *Glossina longipalpis*, 2 *Glossina* pupae, 12 other Diptera, 5 Hymenoptera, 2 Lepidoptera, and 4 Orthoptera ; from Weshiang, Gold Coast.

Dr. H. Hearsey, P.M.O. :—1 Tabanid, 4 *Dacus*, 4 *Drosophila*, and 32 Galerucid Beetles ; from Zomba, Nyasaland.

Dr. A. D. P. Hodges, P.M.O. :—6 Culicidae ; from Uganda.

Imperial Department of Agriculture, B.W.I. :—178 Coleoptera, 8 Coleopterous larvae and pupae, and 3 Hymenoptera (*Polistes*) ; from British West Indies.

Mr. G. P. V. Jervoise, District Commissioner :—40 *Anopheles* Mosquitos ; from Uganda.

Mr. H. L. Jones, Chief Veterinary Surgeon :—38 *Glossina*, 1 *Tabanus*, and 1 *Pangonia* ; from Portuguese East Africa.

Mr. Harold H. King, Government Entomologist :—4 Culicidae, 40 *Phlebotomus*, 2 *Chrysops*, 4 *Glossina*, 6 other Diptera, 5 Coleoptera, and 13 Moths ; from the Anglo-Egyptian Sudan.

Mr. F. A. Knowles, Provincial Commissioner :—67 Ticks ; from Uganda.

Dr. Robt. E. McConnell, M.O. :—93 Culicidae, 1 *Chrysops*, 95 *Haematopota*, 16 *Tabanus*, 87 *Glossina*, 8 *Stomoxys*, 10 *Lyperosia*, 5 *Auchmeromyia*, 2 *Hippobosca*, 40 other Diptera, 3 Dipterous puparia, 1 Flea, 15 Coleoptera, 13 Hymenoptera, 28 Lepidoptera, 1 Ant-lion, 14 Rhynchota, 2 Odonata, 3 Orthoptera, and 1 Centipede ; from Ankole, Uganda.

Dr. C. H. Marshall, M.O. :—12 *Haematopota*, 4 *Tabanus*, 11 *Glossina*, and 13 other Diptera ; from Uganda.

Dr. J. G. Morgan, M.O. :—1 *Haematopota*, 12 *Glossina*, 3 *Auchmeromyia*, 67 other Diptera, 6 Anoplura, 2 Coleoptera and 38 Ticks ; from Nyasaland.

Mr. S. A. Neave:—3,063 Hymenoptera, 16,835 Coleoptera, 5,416 Rhynchota, 12 Odonata, and 68 Orthoptera; from Uganda; and 40 *Chrysops*, 196 *Haematopota*, 63 *Tabanus*, 190 Asilidae with prey, 399 other Diptera, 958 Hymenoptera, 2,886 Coleoptera, 1,353 Lepidoptera, 8 Trichoptera, 2 Planipennia, 534 Rhynchota, 14 Odonata, 3 Plecoptera, 4 Ephemeroptera, 495 Orthoptera, 174 Ticks, and about 30 Isopoda; from Mlanje, Nyasaland.

Dr. J. E. S. Old, M.O.:—2 Culicidae, 70 Tabanidae, 2 Stomoxys, 20 Hippoboscidae, 6 Oestrid larvae, 150 other Diptera, 30 Coleoptera, 1 Coleopterous larva, 30 Hymenoptera, 30 Lepidoptera, 1 Lepidopterous pupa, 10 Myrmeleonid larvae, 50 Rhynchota, 13 Orthoptera, 2 Centipedes, 547 Ticks, 6 Spiders, 3 Scorpions, and a large number of intestinal Worms; from Nyasaland.

Lieut. G. St. J. Orde-Browne, Assistant District Commissioner:—1 Mosquito, 24 other Diptera, 18 Hymenoptera, 5 Coleoptera, 2 Rhynchota; from Embu, British East Africa.

Dr. J. S. Pearson, W.A.M.S.:—4 Culicidae, 78 *Tabanus*, and 2 *Glossina fusca*; from Sierra Leone.

Miss Muriel Robertson:—128 Rhynchota; from Mpumu, Uganda.

Mr. P. H. Ross, Government Bacteriologist:—4 *Glossina pallidipes*; from Kibwezi, British East Africa.

Dr. J. O. Shircore, M.O.:—Type of *Glossina morsitans*, var. *paradoxa*; from Dowa district, Nyasaland.

Dr. Jas. J. Simpson:—4 *Simulium*, 17 Culicidae, 2 *Haematopota*, 4 *Tabanus*, 7 *Glossina*, 2 *Stomoxys*, 33 other Diptera, 1 Jigger Flea, 3 Coleoptera, 84 Hymenoptera, 50 Lepidoptera, a species of Coccidae, 15 other Rhynchota, 26 Orthoptera, 72 Odonata, and 5 Ticks; from the Gold Coast.

Dr. H. S. Stannus, M.O.:—14 *Simulium* and 14 larvae and pupae; from Zomba, Nyasaland.

Mr. F. W. Urich, Entomologist to the Board of Agriculture:—3 Weevils, 19 Coccinellidae, and cocoa-tree twigs attacked by Scolytid and Longicorn Beetles; from Trinidad.

Dr. B. L. van Someren, M.O.:—4 Culicidae, 4 *Stomoxys*, 2 *Hippobosca*, 168 other Diptera, 25 Hymenoptera, and 52 Rhynchota; from Nakuru, British East Africa.

Dr. J. Y. Wood, W.A.M.S.:—34 *Glossina* and 6 other Diptera; from Sierra Leone.

Mr. R. C. Wroughton:—1 Culicid, 1 *Tabanus*, 3 Hippoboscidae, and 178 other Diptera; from Natal.

ENTOMOLOGICAL RESEARCH IN BRITISH WEST AFRICA.

IV. SIERRA LEONE.

By Jas. J. Simpson, M.A., D.Sc.

(*With a Map showing the distribution of* Glossina *and Sleeping Sickness, and 10 photographs by the Author.*)

(Plates XVIII.—XXII.)

Contents.

Introductory.

The following report is the fourth of a series dealing with the blood-sucking insects which are or may be implicated in the transmission of disease in man and other animals. The previous reports have appeared in different issues of this Bulletin* and should be consulted in conjunction with this, as many aspects of a general character, which are equally applicable to all West African Colonies, have been discussed there and need not therefore be reiterated here.

The aims of the author and the methods adopted by him have also been given in considerable detail in the introductory chapter in the Southern Nigeria report and call for no further comment here, but the following paragraph from that report may serve to give some idea of the nature of what follows.

"The main object of the writer in order to further this investigation . . . . was, therefore, to make as extended a tour as possible, visit the various stations,

* I. Gambia, Vol. II., pp. 187–239.
II. Northern Nigeria, Vol. II., pp. 301–356.
III. Southern Nigeria, Vol. III., pp. 137–193.

(32306—2.) Wt. P 12—42. 1000. 11/13. D & S.

and so come in contact with those already interested in such work, or, by explaining the aims and methods of the Entomological Research Committee, to secure the co-operation of those who might be persuaded to aid in the scheme. Consequently, it was impossible for the writer to do any actual experimental work or devote any time to the study of life-histories or such-like investigations in any special locality. The report must, therefore, be considered as a general geographical survey, and taken with other notes and papers published . . . . forms a résumé of recent work. Further it is hoped that it may serve to show not how much, but how little, is known of this aspect of the subject."

The Colony and Protectorate of Sierra Leone was traversed by the writer from March to November 1912, and the report, therefore, deals mainly with observations made during that time, but incorporated with these are the results obtained by other officers, chiefly medical, stationed in the Colony, to whom the thanks of the Committee are due.

The table of contents shows the general arrangement adopted, but a few words are necessary in explanation of this. I have laid great emphasis in previous reports on the factors which influence the distribution of the various blood-sucking insects, and have shown how geographical situation, various topographical features, climate, rainfall and humidity, the length and duration of the wet and dry seasons, and the various types of vegetation all have a bearing on such distribution. In this report I have also added two short chapters dealing with these aspects in Sierra Leone.

The arrangement of the material in the narrative always presents difficulties. It is obviously out of the question to discuss the various political divisions, as these are purely arbitrary and in no way connected with this subject. In the case of Sierra Leone the various routes adopted were chosen so as to follow as far as possible the different river systems, and consequently the narrative follows more or less closely the order in which the different regions were visited. With the aid of the appended map, any one desirous of doing so may easily collate all the information available for any particular district.

A list of all the blood-sucking insects and other arthropods so far known from Sierra Leone has been drawn up for reference, but it must be noted that several new species await description, and doubtless further research will add more.

A map has been added showing the distribution of the various species of *Glossina*, and the route followed by the author has been indicated so that it will be easy to locate any place mentioned in the text. It might be noted that a large number of villages not shown on the original map (G.S., G.S., no. 2082) have been added in red.

Sufficient has been said to indicate the lines along which this report was possible and on which it has been framed, and it is to be hoped that this résumé of work done may help to stimulate others to an elucidation of the important bearing of insects in relation to disease, to indicate lines along which such work may be most profitably accomplished, and to point out the means by which these pests may be diminished in number, and, if possible, eventually abolished.

I. Geography of the Colony and Protectorate.

(1.) Position and Extent.

The colony and protectorate of Sierra Leone lies at the extreme western end of the Gulf of Guinea and, with the exception of the Gambia, is the most westerly British possession in West Africa. It is very irregular in shape, but roughly hexagonal; its extreme depth north and south is about 210 miles, and the extreme breadth east and west is roughly 180 miles. The coast-line runs irregularly in a north-westerly to south-easterly direction; it is about 210 miles in length, and has its extreme limits on the seventh and ninth parallels north of the equator. The total area is approximately 32,000 square miles.

The population of the colony is estimated at 77,000; that of the protectorate at 1,000,000. The Peninsula of Sierra Leone, on which Freetown stands, together with Sherbro' Island, Turner's Peninsula, and a number of small islands, of which the most important are the Banana Islands near the town of Kent on the Peninsula, the Turtle Islands off Sherbro' Island, and the Plantain Islands near Shenge on the mainland, constitute the Colony proper. The remainder is known as the Protectorate of Sierra Leone.

The Peninsula is about 25 miles in length, and from 10 to 12 miles in breadth at the widest part. It is one of the few points on the West African coast where there is high land near the sea. It is formed by a range of volcanic mountains running parallel to the sea; and there are numerous high peaks, the highest of which, Sugar Loaf Mountain, rises in conical form to a height of about 2,500 feet. The mountains are composed principally of syenite and laterite (a decomposition product), and are thickly wooded. They are intersected by numerous ravines and small valleys, and there are considerable tracks of level ground, especially on the eastern side, where it sinks into the mainland.

Freetown, the capital of Sierra Leone and the seat of Government, is situated about four miles up the Sierra Leone River at the foot of the chain of hills already mentioned. It is a large and important seaport and coaling station, with a magnificent harbour—the best in British West Africa; the population being estimated at 40,000 natives and over 1,000 Europeans.

Freetown holds a unique position amongst the ports of West Africa from the fact that a large number of Imperial Troops are permanently stationed there. These include, in addition to a local native regiment, a West Indian regiment and several hundred European troops. It is thus evident that the European population is augmented much in excess of that of any other town in West Africa.

It has already been noted that Freetown is an important coaling station. Practically every steamer which arrives there, either outward- or homeward-bound, takes on coal and water, and this necessitates a considerable intercourse between the steamer and the shore in the form of coolie labour. Further, it must be pointed out that all outward-bound steamers take on native crews at Freetown to work the cargo at the various ports on the coast and put them ashore again there on the return journey. The question of the intercourse between Freetown and the West Indies has also to be considered, when it is

remembered that troops are frequently transferred backwards and forwards between these two places.

From these facts, it will be evident that, from the point of view of the subject in hand, the sanitary conditions in Freetown merit serious consideration in connection with the possibilities of the spread of insect-borne protozoal diseases.

From Freetown a railway runs nearly due east for a distance of about 230 miles, nearly to the Liberian frontier, while a branch railway extends northwards from Boia Junction, about 65 miles from Freetown, through Ronietta, Roruks and Makump, where it crosses the Rokell River.

The only other port of call for ocean-going steamers in Sierra Leone is Bonthe, on Sherbro' Island; but this is visited only by intermediate and cargo steamers, and its importance entomologically will be discussed at greater length in the general narrative.

The configuration of the Protectorate varies much in the different localities. The parts on the banks of the rivers are, for the most part, low and swampy, while away from the rivers the country consists of low rolling downs, with here and there a range of hills rising to a height of about 3,000 feet. The country is well watered by rivers and streams, and is on the whole fertile.

(2.) Vegetation.

It is almost impossible to describe in any general way the distribution of the various zones of afforestation found in Sierra Leone. I have elsewhere* given in greater detail the nature and composition of the various types of forests, and the following classification must, therefore, be taken in conjunction with what was stated there.

As a general rule, it may be said that the type of forest found in any locality depends greatly on the length and duration of the wet and dry seasons respectively, and on the intensity of the rainfall; but the conditions in Sierra Leone have been seriously altered by extensive felling and cultivation on the part of the native. Consequently, the extent of the primeval forest and of the types of vegetation which follow its destruction depends greatly on the density of the population in the various parts.

The forest growths of Sierra Leone may be divided into:—(*a*) tropical rain forests, (*b*) savannah forests, (*c*) fresh-water swamp forests, (*d*) fringing forests and (*e*) mangrove forests.

It will be noted that there are no monsoon forests; this type of vegetation is associated with a fairly porous soil and a distinct differentiation of wet and dry seasons, with the latter more in evidence—a combination of factors not to be found in Sierra Leone.

At one time the whole of Sierra Leone must have been covered by tropica. rain forests, but for the reasons given above, this type is now confined to the tops of mountains and a few isolated portions of the Protectorate. In addition

---

* Bulletin of Entomological Research, Vol. III., p. 143.

to these, one comes across a small patch near every town and village which has been preserved for fetish purposes. These groves are known as the "Bundu" and "Porro" Bush, and their sacred nature prevents their destruction.

As the distribution of the various species of *Glossina* in Sierra Leone depends almost entirely on the distribution of the different zones of afforestation, it might be well to note briefly the regions where each type is at present to be found.

(*a*) Rain forests. This name is given to a characteristic tropical forest in which the trees reach a height of 100 feet and over, and in which there is little or no liana growth. Nearly one-third of the Peninsula of Sierra Leone is covered with forest of this primeval type, while other mountain forests are found on the Kessewe Hills, south-east of Yonnibanna, and on the Kagnari Hills, 20 miles north of Bo (on the railway). These hills extend in a north-easterly direction for ten miles, from Mongheri to Makump. Rain forest is also found on the Kambui Hills north of Kennema (on the railway); on the Nimmini Mountains around Panguma; on the hills around Bumbonla; on the Loma Mountains (in Koinadugu district); also in the Gola Forest near Daru and Kailahun (Kanre Lahun); and on the right bank of the Mano River near Bandasuma and Mendikama.

(*b*) Savannah forests. When primeval rain forest is destroyed it is replaced by a drier type, namely savannah forest, and this in turn gives way to pure savannah. Savannah forests are to be found in the north of the Ronietta, Panguma, and Konnoh districts, and also in Karene and Koinadugu districts. There we find open woodlands with trees which rarely exceed 30 feet in height and which stand at some distance from each other—the intervening space being covered with grass and other herbaceous plants.

(*c*) Fresh-water swamp forests are composed of edaphic forms, and occur in swamps and swampy places. The vegetation is different from that of other forests, and bamboos, wine palms (*Rapha vinifera*) and screw pines (*Pandanus* spp.) are predominant. The ground is covered with shrubs, ferns, and mosses. No general idea of the distribution of these can be given, except that they occur wherever there is low-lying ground and an abundance of telluric moisture.

(*d*) Fringing forests also contain edaphic forms, but not so predominantly as in the case of swamp forests. They are found along the banks of rivers in the savannah country and owe their existence to the permanent supply of water.

(*e*) Mangrove forests are limited to the sea coast and are to be found along all the creeks and in all the rivers up to the limit of tidal influence, *e.g.*, from Freetown to Port Lokko, almost to the town of Rokell on the river of that name, to Kambia on the Great Skarsies River, and to Waterloo. Especially are they predominant in the vicinity of Bonthe on Sherbro Island, and in the numerous creeks and rivers which open into this region.

Without entering into any detail for the present, we might point out that *Glossina palpalis* is to be found predominantly in the mangrove forest, fresh-water swamp forest and fringing forest areas; *G. longipalpis* is restricted almost

entirely to the savannah forest; and *G. fusca* to the tropical rain forest regions. More detailed information of the distribution of these species will, however, be given in the general narrative, but enough has been said to show the bearing of the nature of the vegetation on the subject in hand.

II. Climate and Rainfall.

The Colony of Sierra Leone is small and compact, and at no point is it much over 200 miles from the sea. Consequently, one would not expect to find very great differences in the various parts. It must be remembered also that the meteorological data are very scanty and have not been kept in any regular manner over a definite period. After considerable difficulty I have, however, collected such data as are available, and have arranged them in tables so as to bring out the major features. Only for the year 1911 have I been able to get anything like complete information, but as no attempt has been made, prior to this, to tabulate systematically the data available, it is hoped that this grouping may serve as a basis for future work. The writer is fully aware that further information may modify some of the conclusions arrived at, but it is improbable that any radical changes will be necessary.

There are two distinct seasons in Sierra Leone, known respectively as the "wet" and the "dry." The former is generally spoken of as the "rains." It commences in May and lasts until about October, the commencement and close of the rainy season being heralded by tornados—violent thunderstorms accompanied by strong winds. The minimum humidity occurs at the end of March or the beginning of April, when the moisture is absorbed by the dry harmattan which blows intermittently from December to March. The harmattan is a very hot, dry wind which comes from the north-east, carrying with it fine impalpable dust from the Sahara.

The temperature, on the whole, varies little from day to day, the daily range, as well as the average daily temperature, being least in the middle of the rains, the period maximum of humidity.

Before one proceeds to tabulate and analyse the available meteorological data, it might be well to point out the locations of the various places where these were taken.

(1.) Freetown—the exact locality of this station is described on p. 153.
(2.) Bonthe is also situated on the coast, on Sherbro Island (*see* p. 180).
(3.) Bo is a large station on the railway, 136 miles from Freetown, and about 60 miles from the coast (*see* p. 171).
(4.) Daru is also on the railway, where it crosses the Moa River, 213 miles from Freetown, and less than 100 miles from the coast (*see* p. 172).
(5.) Batkanu is situated on the Rokell River, about 60 miles from the coast; it is the headquarters of the Karene District.
(6.) Kaballa is in the north-east of the Proctectorate, and is the most northerly station in Sierra Leone; it is the headquarters of the Koinadugu District; the country around is mountainous.

TABLE A.

Monthly Temperatures for 1911.

—	—	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
Freetown	Max.	91·3	91·7	92·0	91·7	87·8	86·6	84·1	80·2	85·1	85·1	89·3	89·5	87·86
	Min.	73·8	74·2	74·5	75·2	74·5	71·8	71·7	71·0	71·8	70·9	73·0	72·9	72·94
	Mean	82·55	82·95	83·25	83·45	81·15	79·2	77·9	70·6	78·45	77·5	81·15	81·2	80·58
	Range	17·5	17·5	17·5	16·5	13·3	14·8	12·4	19·2	13·3	14·2	16·3	16·6	15·8
Bo ...	Max.	88·32	94·25	94·3	91·5	88·44	86·3	83·2	81·6	84·8	88·7	87·2	88·4	88·08
	Min.	65·45	68·33	70·2	73·2	71·03	70·2	69·8	69·2	70·3	69·6	69·2	65·7	69·36
	Mean	76·88	81·29	82·2	82·7	79·73	78·2	76·5	75·4	77·5	79·1	78·2	77·05	78·72
	Range	23	26	24	18	17	16	14	12	14	19	18	23	18
Batkanu	Max.	90·9	95·3	96·27	95·4	93·8	90·6	86·8	84·67	87·12	90·04	89·3	89·09	90·77
	Min.	67·6	69·4	71·87	74	74	72·5	72·35	71·93	72·88	72·5	72·85	69·46	73·4
	Mean	79·2	82·3	84·07	84·7	83·9	81·5	79·57	78·3	80	81·27	81·67	79·27	81·26
	Range	23	25	24	21	19	18	14	13	15	18	17	20	19
Daru ...	Max.	86·86	97·17	94·14	89·7	89·6	86·9	83·3	86·7	87	89·6	93	87·4	89·28
	Min.	58·86	69·5	69·09	70·14	71·4	71·3	70·3	69·5	70·7	69·9	69·5	66·5	68·89
	Mean	71·86	83·3	81·6	79·9	80·5	79·1	76·8	78·1	78·8	79·7	81·2	76·9	79·73
	Range	28	28	25	19	18	15	13	17	17	20	24	21	20
Kaballa ...	Max.	92	94	96·9	95	92	87	83	82	84	86	87	89	88·99
	Min.	60·3	65	47·8	49	49	47	69	66	67	61	50	58	57·42
	Mean	76·14	79·5	72·35	72	70·5	67	76	74	75·5	73·5	68·5	73·5	73·2
	Range	31	29	49	46	43	40	14	16	17	25	37	41	32

The foregoing table gives the maximum and minimum temperatures for each month in 1911, taken at five stations. A cursory glance is sufficient to show that, with the exception of Kaballa, there is very little variation at any of the meteorological stations, either as regards the monthly distribution of the maximum or minimum temperatures or the annual mean. The monthly range of temperature is also similar at all four stations. Kaballa, however, is furthest from the coast, being situated on a high range of hills, and consequently, although the maximum there is nearly the same as at the other stations, the minimum is considerably less, and the range is increased correspondingly. To this fact we shall return later when discussing this station.

TABLE B.

Monthly Record of Rainfall in inches in 1911.

—	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Bonthe	1·00	0·43	0·40	2·95	11·82	23·19	24·54	33·53	25·66	17·33	8·17	0·71	149·63
Freetown	0·01	0·07	0·02	0·66	4·00	15·52	26·05	36·08	33·04	14·23	6·00	0·91	136·59
Bo ...	0·35	0·25	4·51	2·50	7·14	18·29	13·21	26·41	25·93	11·00	9·22	0·35	119·16
Batkanu	—	—	0·87	2·71	8·24	13·66	18·03	17·15	18·95	19·99	7·61	0·62	107·73
Daru ...	—	3·38	4·42	10·45	15·65	7·63	7·93	7·16	14·02	8·44	8·12	—	87·20
Kaballa	—	—	0·10	3·76	6·68	10·31	11·07	14·52	18·86	14·59	0·24	—	80·13

This table gives the monthly record of rainfall in inches for six stations in 1911. It serves to show graphically the duration of the wet and dry seasons

and the intensity of the rainfall in each month. The first obvious deduction to be made from it is the enormous rainfall in the coast towns, *i.e.*, 149·63 inches at Bonthe and 136·59 inches at Freetown, with a progressive diminution in the places more remote from the coast; *e.g.*, Bo and Batkanu (60 miles), 119·16 and 107·73 respectively; Daru (100 miles), 87·20 inches, and Kaballa (about 150 miles), 80·13 inches.

On one year's data it is hardly permissible to compare the monthly distribution of the rainfall, but the contrast between Bonthe and Kaballa can hardly be overlooked.

TABLE C.

Number of days on which Rain fell in 1911.

—	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Freetown ...	2	1	1	6	18	29	30	30	26	27	11	3	184
Bonthe ...	1	1	2	9	19	23	29	30	26	24	15	2	181
Bo	2	1	7	11	19	25	30	28	29	25	15	1	193
Batkanu ...	—	—	2	6	9	26	31	31	27	30	14	1	177
Daru ...	—	5	10	12	18	21	21	19	22	20	15	—	163
Kaballa ...	—	—	1	8	13	22	25	23	23	26	5	—	146

Table C shows the number of days on which rain fell in each month in 1911 at the same six stations. In each case Bo is rather anomalous, but no deduction is advisable from only one year's records. On the other hand, this table bears out the last in such a way as to show that not only does the rainfall diminish in amount from the coast northwards, but the number of wet days also diminishes in a like manner; in other words, the total amount of rainfall is not due to greater concentration on a few days but is spread more uniformly over the rainy period.

TABLE D.

Percentage Humidity in 1911.

—	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
Bonthe ...	83	84	75	84	84	84	84	88	74	89	82	89	83
Freetown ...	79	76	76	75	82	84	88	90	87	82	80	79	82
Daru ...	78	62	70	74	90	85	88	88	90	87	79	83	80
Bo	63	64	92	71	80	84	84	83	83	79	83	75	78
Batkanu ...	66	60	75	67	80	80	83	89	79	88	84	83	77
Kaballa ...	48	58	56	66	78	78	88	88	83	82	83	54	71

In the above table is given the percentage humidity for each month in 1911 at the same six stations, and here again we find that the mean annual humidity is much less in the hinterland than on the coast. But it must be noted that the annual mean is not proportionately decreased by every monthly mean. During the rainy season—July, August, September, October and November—the humidity of Kaballa varies but little from that at Freetown (in one month,

November, it was actually higher). In other words, the humidity on the coast is more evenly distributed throughout the year, and a diminution in the rainfall in that region does not involve a corresponding diminution in humidity.

TABLE E.

Number of days on which Rain fell in Freetown in 1911.

—	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1905 ...	2	—	—	3	12	27	25	27	23	21	12	3	155
1906 ...	—	3	2	6	22	24	26	23	21	19	6	10	152
1907 ...	—	—	—	—	—	—	—	—	—	—	—	—	160
1908 ...	—	—	2	3	17	22	20	24	29	23	11	—	151
1909 ...	2	2	8	6	21	23	29	29	26	23	16	4	189
1910 ...	—	—	3	4	15	24	31	30	24	23	11	5	170
1911 ...	2	1	1	6	18	29	30	30	26	27	11	3	184
1912 ...	—	2	—	2	11	26	30	24	21	18	8	3	145

Table E gives the number of days on which rain fell in Freetown from 1905 to 1912, with the exception of 1907, and shows that with few exceptions the number of rainy days is fairly constant. It will also be seen from this table that the months of June, July and August may be regarded as the period of heaviest rainfall.

The following table for 1911 will serve to emphasise in a graphic manner some of the deductions from the foregoing tables.

TABLE F.

—	Freetown.	Bo.	Batkanu.	Daru.	Kaballa.
Greatest amount of rain on one day	7·47″	7·08″	4·58″	2·45″	2·25″
Highest Temperature recorded ...	96·4°	99°	92·8°	97·8°	100°
Lowest Temperature recorded ...	65·8°	52·8°	60°	55°	41°
Greatest diurnal variation... ...	—	34·8°	26·6°	33·4°	57°

III. NARRATIVE.

(1.) Freetown to Port Lokko, Kaballa and back to Port Lokko.

This journey was accomplished between 19th March and 30th April 1912, *i.e.*, towards the end of the dry season when insect life is at its minimum. Consequently, it must be remembered that the number of species or even the number of specimens of any one species cannot be taken absolutely as a criterion of prevalence. A glance at the map will show that the records for *Glossina* on this trip are much fewer than on any succeeding journey, but at the same time there is little doubt that many more of the different species would have been found a month or two later.

The journey from Freetown to Port Lokko is made by steam-launch up what is known as the Sierra Leone River. In the early part, this waterway is very

wide, and consequently the launch never approaches the bank within the limit of flight of blood-sucking insects. After passing Tumbo Island which lies at the mouth of the Rokell River, the steamer enters the Port Lokko Creek, and this gradually narrows towards Port Lokko. Its banks are covered with mangrove swamp, and the number and variety of blood-sucking insects which inhabit its shores may be gauged from the fact that twenty-seven specimens belonging to seven different species were caught (very many more were seen) in about an hour in the launch, which was going at a speed of over 8 miles an hour. The following are the species referred to:—*Glossina palpalis*: *Tabanus fasciatus*, *T. laverani*, *T. socialis*, *T. kingsleyi*, *T. besti* var. *arbucklei*, and another species of *Tabanus* closely allied to *T. kingsleyi* but probably new.

Port Lokko is an important town situated at the head of this creek. It is the headquarters of a sub-district of Karene, and a District Commissioner is stationed there. Two companies of the West African regiment are also permanently quartered there. A launch runs weekly from Freetown to Port Lokko, but in addition to this there is a considerable number of large canoes continually carrying produce between these two places. Port Lokko is the terminus of one of the longest trade routes in the Protectorate, namely the Falaba-Port Lokko Road. Immense quantities of produce continually pass backwards and forwards along this road on the way to and from Freetown. There is one European and many Syrian stores; the permanent population is large, and the floating population sometimes exceeds a hundred daily.

The only blood-sucking flies caught in Port Lokko itself were *Glossina palpalis* and *Tabanus laverani*, and both these species were obtained in the rest-house. Two species of ticks were found, namely, *Haemaphysalis leachi* from a dog, and *Haemaphysalis parmata* from a harnessed antelope (*Tragelaphus scriptus*). Mallophaga were also found on a bush rat and a harnessed antelope, but these have not yet been identified.

The route from Port Lokko to Kaballa and back to Port Lokko now to be described, is not one of the main roads in the Protectorate, but was selected as a means of examining the basins of the Great and Little Skarsies Rivers. The road from Port Lokko to Kambia crosses the Little Skarsies at Mange; from Kambia to Yana it follows the Great Skarsies; from Yana to Kamagbonse it again crosses the basin of the Little Skarsies; from Kamagbonse to Kamakoni it passes along the Mango River, which is a tributary of the Little Skarsies; while the remainder of the journey follows the Little Skarsies itself. The complete circular tour, therefore, gives a fairly comprehensive survey of these two river-systems.

The country from Port Lokko to Kambia is undulating, but less so after passing Mange on the Little Skarsies River. The general type of vegetation might be described as orchard-like, thin bush or low scrub, but wherever there are water-courses one finds heavy bush with large trees and interweaving lianes, giving dense shade. The varying nature of the vegetation in the open country away from the rivers is due to the mode of cultivation adopted by the natives. A strip of bush is cut down, burnt, and cleared for a rice farm. After the crop has been taken off, the ground is allowed to remain fallow for five years or more. Consequently the bush grows again, and the height and density of the vegetation

varies according to the number of years which have elapsed after the original clearing. The trees never attain any great height, but the undergrowth becomes denser and denser. The country is very populous, so that very little virgin forest now remains, in fact in this region it is almost entirely restricted to the fringing forests along the banks of the water-courses.

No blood-sucking insects were seen on this three days' journey, but it is more than probable that many exist at the various streams in the rainy season.

Kambia is a large and important town standing on the Great Skarsies River. Large sea-going canoes can ascend to this point at high tide even in the dry season, and this to a great extent determines its position. It is situated at the limit of tidal influence, and although the river bed consists of a mud flat when the tide is out in the dry season, it is several feet deep and about 200 yards wide at high water. A rocky outcrop which crosses the river acts as a dam, beyond which it is dangerous for large canoes to ascend. The banks are covered with heavy dense vegetation, and *Glossina palpalis* is to be found here all the year round.

Between Kambia and Yana the road is never far distant from the river and passes through several large towns, the most important of which are Bassia, Kukuna and Konta. The country is undulating and gradually becomes more hilly towards the north. The nature of the vegetation varies in the different places according to the density of the population and the amount of annual cultivation. On the whole it may be described as open bush country, but everywhere along the banks of the rivers and streams there is the usual heavy densely-shaded bush with high overhanging trees. The only blood-sucking insects seen during this trek were *Glossina palpalis* and *Tabanus laverani*. The former was found at Konta and Yana, the latter at Ganya. Ticks, however, were not uncommon; *Haemaphysalis leachi* was obtained from a dog, and *Amblyomma variegatum* and *Boophilus australis* were found in a cattle compound at Konta.

Konta is an important town situated on the left bank of the Great Skarsies. A custom's clerk is stationed here, as it is on one of the main trade routes between French Guinea and Sierra Leone, the river at this part forming the boundary between these two countries. According to this clerk, who was stationed there during my visit, tsetse are extremely troublesome in Konta during the rains, but diminish in number in the dry season, although they never entirely disappear.

A few cattle are to be seen at nearly every town on this road. They are not very large, are chiefly of a dun colour, have long horns, and no hump (Plate XVIII, fig. 1). The majority of them were in excellent condition and they seem to thrive well. Horses too are not uncommon—a remarkable occurrence for Sierra Leone, in most parts of which horses are practically unknown. Their presence here is due to the proximity of this part to French Guinea, and all have been brought at one time or another from that country.

The question of animal transport in Sierra Leone has occupied the attention of the Government for some time, and a number of donkeys were taken from the Gambia to Sierra Leone and sent to Port Lokko—perhaps the most unfortunate

situation which could have been selected. I shall return to this question later, but in the meantime, I should like to recapitulate what information I could gather from the owners of the various horses seen.

At the town of Pettifu there were two horses, one mare and one stallion, which had been brought from French Guinea about four months before. They both showed typical signs of trypanosomiasis, *e.g.*, considerable oedema of stomach, legs and scrotum ; but I was unable to discover whether these symptoms had developed prior or subsequent to their importation into Sierra Leone. A mare at Laminaia also showed signs of trypanosomiasis, and trypanosomes were found in its blood. On the other hand, one horse which had been in Bassia for over four years looked perfectly normal and healthy, and no history of swelling or sickness could be elicited from the owner, who rode it frequently. At Kukuna there were two horses ; one had been there for about a year and seemed quite sound, the other presented very marked symptoms of trypanosomiasis, but the owner assured me that it had been six years in Kukuna and had never been what he called "sick," although it had always shown the same amount of oedema.

The subject is therefore well worth further investigation. Game is abundant in this region, and an examination of the blood of the various types, together with a systematic study of the different blood-sucking insects which are to be found there, might lead to very definite results. It is more than probable that the only species of tsetse in this district are *Glossina palpalis* and *G. longipalpis*.

Soon after leaving Yana, one enters the valley of the Little Skarsies, or the Kabba, the name by which it is known in this region. The country is very mountainous, and as the majority of the towns are situated either on the side or the top of lofty hills, trekking is very arduous—up one side of a hill some 900 feet and down the other. The sides of the hills and valleys are densely clad with heavy forest, but in most cases the tops of the hills are covered with grass and thin scrub. The sides of the hills are intersected by deep ravines which carry torrential streams in the wet season.

While the writer was crossing the River Lolo, a tributary of the Kabba, which in the dry season is merely a trickling stream with numerous small pools, *Stegomyia fasciata* was caught, along with *Tabanus kingsleyi*, while nearer Kondita the same species of *Tabanus* and also *Tabanus besti* were found. At the town of Kondita itself, at least one other species of *Tabanus*, not yet identified, was troublesome, and it is interesting to note that males of this species were obtained—a very rare occurrence. On the banks of the River Kabba, between Kondita and Kamagbonse, *Glossina palpalis* occurs. At Kamagbonse cattle, sheep and goats seem to thrive well.

The road from Kamagbonse to Kamba climbs steeply through thick bush and cane brakes to a height of 1,150 feet, when the country opens out into thin bush and scrub. About 2 miles from Kamagbonse *Glossina longipalpis* was captured. Kamba is the principal town of the western kingdom of the Yallunkas; it is well situated in an open clearing on the top of a large circular hill, and is extremely clean. The water supply is at the foot of the hill, and in the valley in which the stream runs the following blood-sucking insects were found :—*Glossina longipalpis*, *Tabanus* sp., *T. kingsleyi*, *T. quadrisignatus*, and one species of *Haematopota* near *cordigera*.

Between Kamba and Mussaia the country is broken, several hills of 500–600 feet rising up from the general level of the plateau. The vegetation consists of open bush, a certain amount of grass land (savannah-like), and frequent bamboo clumps—typical country for *Glossina longipalpis*. The town of Mussaia is situated about a mile from the Mango River. It is a very old town, the capital of the Yallunka kingdom, and is surrounded by an enormous stockade of large cotton trees. In the town itself mosquitos were very troublesome and a large number of both *Anopheles funestus* and *A. costalis* were caught. *Glossina palpalis* was found at the watering place on the Mango River and also in the town, along with *Tabanus pertinens* and *Tabanus* sp., the former of which was very abundant. A large number of ticks, *Haemaphysalis leachi*, were taken off the dogs and cattle.

The country between Mussaia and Kaballa consists of an open plateau covered with grass and a certain amount of thin bush merging in several places into open orchard-like patches.

The town of Kaballa is the headquarters of the Koinadugu District, and is excellently situated in a very mountainous region at an altitude of between 1,600 and 1,700 feet. Formerly it was one of the posts of the West African Frontier Force, but the troops have now been removed to Daru. Two European officials are, however, still stationed there, namely, a District Commissioner and a Medical Officer. The general plan of the station is as follows :—Several small hills, separated by shallow valleys, form a cresent, which encloses an extensive level plain, and opposite these are two other hills with valleys on each side which descend to the same level as the plain. On the highest of the first-mentioned hills stands the Commissioner's bungalow, with a commanding view of the station below and a large portion of the surrounding country. On another of these hills, but much lower down, is the Medical Officer's house, while still lower down—on the road to the plain—is the Europeon rest-house. On the plain below (Plate XVIII, fig. 2) are situated the District Office, Post Office, Hospital, Jail, court messengers' barracks and clerks' houses. At one side of the valley there is a small stream which in the rainy season forms an extensive swamp, and it is noteworthy that the prevailing wind blows across this swamp towards the European quarters.

The slopes of the hill between the native lines and the European quarters are covered with low scrub and grass, and tall elephant grass actually extends to within a few yards of the Medical Officer's house. Cassava is extensively grown around the court messengers' lines, the clerks' quarters, the jail and the hospital. There can be no doubt that this state of affairs accounts to a great extent for the prevalence of mosquitos, sandflies, and other biting insects in Kaballa, and until the whole of this area is cleared, no hope for a diminution of these pests can be expected. Malaria is said to be extremely common in Kaballa, and one case of sleeping sickness was diagnosed there.

At the time of my visit, mosquitos were very troublesome, far in excess of what should be expected at that season of the year. The chief species found were *Anopheles funestus*, *A. costalis* and *Stegomyia sugens*. A small sandfly, *Ceratopogon* sp., constituted one of the chief pests. Other blood-sucking insects caught in Kaballa include *Tabanus kingsleyi*, *Tabanus laverani* and *T. besti* var. *arbucklei*. *Ctenocephalus felis* is not uncommon, while *Rhipicephalus sanguineus* and *Haemaphysalis leachi* were obtained from dogs

One cannot emphasise too strongly the necessity for extensive and continued clearing in Kaballa station.

From Kaballa the country is very hilly to Katanta, and the road, though following the valleys in places, nevertheless crosses over some moderately high hills. These hills are much more rocky than in the north, and the vegetation is scantier, but the valleys are thickly wooded, and oil palms occur in great numbers. Some of the towns are situated on the tops of these rocky hills, and are very inaccessible. Simimaia, the first of these at which a halt was made, is a densely populated Warra-Warra Limba town, built on a granite shelf on the south-east side of a ridge at a height of 2,300 feet. *Haemaphysalis leachi* was found on the cattle in this town.

Between Simimaia and Bafodea, *Glossina palpalis* was caught in numbers on the banks of the Mantia Stream, while *Tabanus kingsleyi* occurs in the town of Bafodea itself. The same species of tick as that found at Simimaia was obtained from the cattle here. Between Bafodea and Kamakumba the country is open, and the hills are very rounded, boss-like, and covered with grass, a few trees and some low scrub. The town of Kamakumba is situated in a kurimi, and *Glossina palpalis* was very abundant. Not far from Kamakumba *G. palpalis* was again found in a kurimi, and at the next halting place, Kamatoto, the same species of tsetse was taken, along with *Tabanus kingsleyi* and *T. argenteus*.

Kamatoto is a new town under a Limba Chief, but the great majority of the inhabitants are Foulahs and Mandingos who migrated from the town of Karima (*see* p. 167) owing to the population of the latter place becoming too large for the food supply, and the lack of grazing for their cattle. The migration commenced in April 1911, and over 200 head of cattle were transferred. In October of the same year the cattle began to die off, and before the following March 189 in all had died. The owners informed me that, prior to death, the cattle became emaciated, and in some cases the heart was considerably swollen. The general symptoms and course of the disease as described by the natives led one to suspect trypanosomiasis. The natives attributed the deaths to two causes : (1) they say that if cattle eat grass which has been previously cropped by bush-cow, the former inevitably die ; (2) they attributed some of the deaths to a fly which they call Sisafi, and which they describe as slightly larger and darker than a tsetse. They had never caught one of these flies, but gave this opinion from the recollection of those which they had seen on the cattle and which were compared with some specimens of *Glossina palpalis* which I showed them. Their idea, however, was that these flies sucked all the blood, and the cattle died of anaemia. The connection between the deaths of the cattle on one hand and bush-cow and a blood-sucking insect on the other, in the mind of the native, is, to me, suggestive, when it is remembered that this information was given quite voluntarily and not after a number of leading questions.

A similar state of affairs to that described above came to my notice at a place called Yiraia Sokurella, also in Koinadugu District. A number of cattle, which were quite healthy when quartered in the town with its surrounding clearing for farms, were transferred to a new cattle compound about a mile from the town. This compound was made in an absolutely new clearing in the bush. In a short time, sickness broke out and soon all had died, while those left in the town were perfectly healthy.

In both these places, bush-cow and other forms of game are abundant, and in both places tsetse occur. Can it possibly be that, in making a new clearing in an area which has been overrun with game, a race of tsetse infected with a virulent strain of trypanosomes may be encountered, and that after extensive clearing has been accomplished and the game has been driven back, the infected insects die off, and the percentage of infected tsetse in succeeding generations becomes gradually less owing to the source of infection (on the assumption that this is the game) being reduced in numbers or removed altogether ?

Whether this be the case or not cannot be determined off-hand, but it opens up a fruitful line of enquiry, and one which is of great importance to the Colony, inasmuch as it affects the native and European food supply, one of the chief industries of the natives, and a source of revenue to the Colony.

These two cases furnish an object lesson to the administration with regard to the removal of cattle from towns. There can be no doubt that there are too many cattle kept within the precincts of towns in Sierra Leone, but in view of these facts it would be highly injudicious to order the immediate transference of such cattle to camps some distance away. It might be well to see that the area selected for such camps was thoroughly cleared at least one year in advance of the removal of the cattle.

From Kamatoto to Karassa the country is open ; bush-cow and elephant are not uncommon. *Glossina longipalpis* occurs in the bush, and *G. palpalis* was found on the banks of the Mango River. Near Katanta, on the same route, is a small stream which flows into the Mango River. *G. palpalis* was abundant there, and *Tabanus laverani* was found in the town itself. Two species of ticks, namely, *Amblyomma tholloni* and *Dermacentor circumguttatus*, were obtained from an elephant. This is the southern end of the hilly region. After Katanta the country slopes more gradually to the coast.

Between Katanta and Kamakwie, the only blood-sucking insect seen was *Tabanus kingsleyi*, but at Kamakwie, ticks (*Rhipicephalus sanguineus*) were found on dogs. Between Kamakwie and Kamakoni, the country is open and there is a large number of small villages. The following species were caught on this journey :—*Tabanus laverani*, *T. kingsleyi*, *T. quadrisignatus* and *Glossina palpalis*, while *Haemaphysalis leachi* were found on dogs. It is worthy of note that no fewer than eight male Tabanids were obtained between Katanta and Kamakoni on 21st and 22nd April—an exceptionally large number out of a total of thirteen.

Towards Laminaia, there are numerous extensive swamps, some with very tall, and some with short grass ; there are also large rice farms—a type of country which reminds one of parts of the Gambia. Game is plentiful here including bush-cow, water-buck, cob, harnessed antelope, and duiker. The town of Laminaia is very dilapidated and filthy. A large herd of cattle is kept, and as these are all quartered within the town, houseflies constitute a regular pest.

G. palpalis was found near the river, and *G. longipalpis* in the more open parts ; *Tabanus pertinens* was caught in the town itself, while the dogs and cattle simply swarmed with *Haemaphysalis leachi*, *Boophilus australis* and *Rhipicephalus sanguineus*. A number of immature nymphs of a species of *Amblyomma* were found on a water-buck.

The next two towns at which a halt was made, namely, Resorse and Rowerre, are what are known as "true cattle towns." Resorse is a large town of over 200 compounds, and Rowerre, is only slightly smaller. Each compound consists of one or more houses situated within a large strongly fenced cattle corral. The cattle are driven out to pasture during the day, and return at night to the corrals. Sometimes between one and two thousand cattle may thus be quartered in the town. These compounds are not over-clean, and the plague of flies may be better imagined than described. The following blood-sucking flies were caught at Rowerre :—*Glossina palpalis*, *Tabanus laverani*, and *T. kingsleyi*; while the cattle and the compounds swarm with ticks, chiefly *Amblyomma variegatum* and *Boophilus australis*. Rowerre may be regarded as the southern limit of the cattle country of the Timanis. The country south of this is practically all grass land with forests of African oak. It is very sparsely inhabited and there is little cultivation.

The only blood-sucking insect seen between Rowerre and Port Lokko was *G. palpalis*, while we were crossing the Mabole River at Mabanta. The latter is one of the outpost stations of the West African Regiment.

(2). Port Lokko to Kaballa, *via* Batkanu (main route).

The road from Port Lokko to Kaballa, *via* Batkanu, is at present the main north route for all officials to and from Kaballa. As soon as the northern extension of the railway crosses the Rokell River at Makump, a closer connection will be established with Freetown, and it is probable that this route will be more extensively used.

The Batkanu road runs in the valley of the Mabole almost the whole way to Kaballa, but the latter part lies in the basin of the Mawolo River. From Port Lokko to Batkanu the chief towns passed are Konta and Roballandugu. The whole of this country is practically level and the vegetation is park-like, with patches of low bush and grass land, and abundant oil palms. No blood-sucking flies were seen on this march.

Batkanu is a small town of about 25 huts on the Mabole River. Its importance, however, lies in the fact that it is the headquarters of the Karene district. Here are stationed a District Commissioner, an Assistant Commissioner, and a Medical Officer. The European station is situated some distance away from the native town and is a model of what can be done in the way of laying out and maintaining a station. Col. Warren, the District Commissioner, is fully alive to the necessity of extensive clearing, and not only is this being carried out around the station, but he has prohibited the growing of any crops within the station which might tend to shelter or serve as breeding places for noxious insects.

It might be noted, however, that the thick low bush which extends between the river and the Medical Officer's bungalow might with advantage be cleared in the vicinity of the bungalow, or, better still, when the time comes for the erection of a new bungalow, a new site might be chosen further away from the river.

The country around is park-like, with extensive stretches of grass. These latter are inundated with water during the rains. The banks of the river are very high and steep and are covered with dense bush and overhanging trees.

The advantage of clearing an area on either side of the watering places and main crossings might be considered. Game is plentiful within a very short distance of the station.

The following blood-sucking insects have been found at Batkanu :—*Glossina palpalis*, *Tabanus kingsleyi*, *T. taeniola*, *T. par*, *Culiciomyia nebulosa*, *Anopheles costalis*, *Stegomyia fasciata* and *S. sugens*. The commonest tick is *Haemaphysalis leachi*.

Between Batkanu and Karima, the boundary between the Karene and Koinadugu districts, the road crosses the River Mabole twice. The country is practically level, and the general type of vegetation is similar to that south of Batkanu. One species of *Haematopota* was seen, but not captured, on this road.

Karima is a large cattle town of about 150 huts situated on the right bank of the Mabole River. Formerly it was much larger, but owing to its increasing size and the paucity of farming land and pasture, several small towns have separated off. One of these is Kamatoto, to which reference was made on page 164. The town of Karima is laid out in practically the same manner as Rowerre (*see* page 166). *Glossina palpalis* was the only blood-sucking fly seen there.

North of Karima, the hilly country is again entered and this extends the whole way to Kaballa. The road lies in the valleys of a long mountain range, so that with the exception of a few places travelling is not arduous.

Near Kaniki, the hillsides and valleys are covered with thin bush, and the country is extensively farmed. At this town *G. palpalis* and a species of *Ceratopogon* were abundant. Between Kaniki and Kafogo, *G. palpalis* was found at most of the streams, and *Tabanus kingsleyi* was seen at several places. At Kafago the following were caught :—*G. palpalis*, *T. kingsleyi*, *T. besti*, *Simulium damnosum*, and *Ceratopogon* sp. From Kafogo to Kaballa, the road passes through Igaia. The country is mountainous as before and the vegetation is very similar to that described, but if anything, slightly higher and denser. At Igaia, *Glossina palpalis*, *Tabanus besti* var. *arbucklei*, and *Hippocentrum trimaculatum* were found. It is worthy of note here that between Igaia and Karassa (*see* map) *Glossina longipalpis* and *G. fusca* were captured by Dr. J. Y. Wood—the former at two places, the latter once.

(3.) Kaballa to Hangha.

The route now to be described is a very tortuous one (*see* map), and is divided between three distinct river systems :—the Rokell, the Bum or Sewa, and the Moa. The journey was accomplished between 30th May and 3rd July, a season when travelling was arduous and not without its discomforts, owing to the rains having set in, but at the same time a season when insects are much more numerous than in the preceding months.

The road from Kaballa to Yiraia Sokurella, *via* Falaba and Kombile, encircles the head-waters of the Rokell River (known as the Seli in this region), and crosses, not only the Rokell itself near its entry into Sierra Leone, but also a large number of its tributaries. From Kaballa the road to Falaba passes through Benikoro and Sonkonia, and this is part of the main Falaba-Port Lokko Road. The country is hilly, but the road for the most part follows the valleys.

The vegetation becomes more and more scanty towards the north, and the dense bush which clothed the hillsides and valleys south of Kaballa is gradually replaced by grass.

At the town of Benikoro, the following blood-sucking insects were captured—*Glossina palpalis*, *Tabanus kingsleyi*, *T. biguttatus*, *Hippocentrum trimaculatum*, *Stegomyia fasciata*, *S. sugens*, and *Ceratopogon* sp. *Stegomyia fasciata* was also caught at the riverside some distance from the town. Within the town itself I came across a "dug-out" log containing water used for tanning, and this vessel simply swarmed with *Stegomyia* larvae.

At Sonkonia, *G. palpalis*, *Hippocentrum trimaculatum*, *Anopheles funestus*, and *Stegomyia sugens* were the only blood-sucking insects obtained.

Falaba, a large town of over 200 houses, is an important trading base. *Tabanus kingsleyi* was troublesome on the road, while at Falaba itself the following were caught:—*G. palpalis*, *Tabanus* sp. n., *T. kingsleyi*, *T. taeniola*, *T. laverani*, and *T. subangustus*.

Between Falaba and Kombile, the country consists of low rounded hills almost entirely covered with grass. The whole area is burnt during the dry season, and this, to a great extent, accounts for the small number and the unhealthy appearance of the trees which remain, and the preponderance of grass. The only town of any size on this route is Gberea, but there are many fakais—the local name for small temporary farms or grazing grounds. Many cattle are kept in this region, and they are, on the whole, healthy-looking. One horse was seen at Kombile with all the outward signs of trypanosomiasis.

At Gberea, the following blood-sucking flies were obtained:—*Glossina palpalis*, *Tabanus* sp. n., *T. kingsleyi*, *T. ruficrus*, *T. subangustus*, *T. congoiensis*, and *Stegomyia fasciata*; while at Kombile only *G. palpalis* (at the River Seli) and *T. kingsleyi* were captured.

Between Kombile and Serakolia, the country is an extensive undulating plateau intersected by small steep ravines. These ravines are covered with dense vegetation and abundant undergrowth. In most of these, *G. palpalis* was found. The plateau consists of open orchard-land, is park-like in character, or what is often described as open, African Oak forest. *Glossina longipalpis* was caught on the plateau. In addition to these two species, *Tabanus* sp. n., *T. kingsleyi*, *T. subangustus*, and *Hippocentrum trimaculatum* exist.

From Serakolia to Yiraia Sokurella is a long and arduous journey over very hilly country with abundant low bush; there are numerous small streams and swamps, and the road would hardly be passable towards the end of the rains. A very interesting feature of this journey was the finding of mosquito larvae in the "bush." At a small river called the Waliki, while searching for pupae of *Glossina*, I came across several isolated pools in rocks, containing mosquito larvae. On breeding these out I found them to be *Stegomyia sugens*. A little further on, while crossing a large expanse of exposed rock at least 40 yards from any shade, I came across another pool of water, less than one inch in depth, also containing larvae. I had no thermometer to take the temperature of the water, but it was distinctly "warm" being exposed to the full force of the mid-day sun. These also turned out to be *S. sugens*. It may be noted that both these places were at least five miles from any human habitation and on a route that is not very frequented.

At Yiraia the following blood-sucking insects were taken :—*Glossina palpalis*, *G. longipalpis*, *Tabanus kingsleyi*, *T. pluto*, *Simulium damnosum*, and *Culiciomyia nebulosa*. The last-named species was bred from larvae found in a pit containing a filthy liquid mass used in tanning. One tick, *Amblyomma splendidum*, was found on grass, and another species, *Rhipicephalus sanguineus*, was taken along with *Ctenocephalus felis* from dogs.

The first stage from Yiraia Sokurella is to Banda Karafa, with a halt at Firiwa. The country is hilly, and there are numerous kurimis. In several of these kurimis, *Glossina palpalis* was caught, while in the more open country *G. longipalpis* exists. At the town of Firiwa itself, in addition to the former species, *Tabanus kingsleyi* and *T. pluto* were taken. From a borrow-pit near the rest-house, swarming with mosquito larvae a number were taken. These, on being bred out, proved to be *Stegomyia sugens*, while from a tan-pit in the town, and from a hole in a decayed tree near the rest-house, several *Stegomyia fasciata* were bred out. One species of tick, *Haemaphysalis leachi*, was found on grass. At the crossing of the Bagwe (or Bagbe) River, as the Bum River is called in its higher reaches, and also at a tributary, *G. palpalis* was found on the road to Banda Karafa, while near this town the same species of *Glossina*, along with *G. longipalpis*, *Tabanus besti* and *T. kingsleyi*, were captured.

From Banda Karafa to Tirikoro the road passes round the base of the Loma Mountains and another smaller chain of hills which forms an eastern continuation. All the towns are situated high up on the rocky hillsides, and the vegetation is very dense. Numerous small streams and swamps had to be crossed, and travelling in this region is extremely arduous. The first town of any size on this journey is Kimadugu, where *Glossina palpalis* and *Tabanus argenteus* were found. A number of *Culiciomyia nebulosa* were bred from larvae obtained from a " medicine " or " ju-ju " pot. Between this town and Kurubum, several *Hippocentrum trimaculatum* were caught, chiefly in the vicinity of the swamps mentioned. *G. palpalis* and *T. kingsleyi* were found near Kurubum. At Sandea, a small filthy town on the hillside, *G. palpalis* and *Stegomyia fasciata* were abundant ; while at Tirikoro only *Tabanus besti* var. *arbucklei* and *T. pluto* were seen. The country around Tirikoro, an unimportant dirty village, is extremely interesting geographically, as it contains the sources of four large rivers. Its chief importance lies in the fact that here the Niger takes its origin, and flows almost due north ; north-west round the Loma Mountains runs the Bagwe or Sewa or Bum ; south-west flows the Bafi, a tributary of the Bagwe ; and south-east runs the Mum, a tributary of the Meli.

Near the source of the Niger, in an exposed rock pool, similar to that described on page 168, several mosquito larvae were obtained and bred out. These proved to be *Stegomyia sugens*.

From Tirikoro to Kondundu the road traverses the region watered by the River Mum, a tributary of the Meli. The only blood-sucking flies obtained on this stage were *G. palpalis*, *Haematopota grahami*, and *Stegomyia fasciata*. The last-named were bred from larvae found in a hollow of a decayed tree near the River Mum. The country from Kondundu to Jahama lies in the basin of the River Bafi, a large and important tributary of the Bagwe. Owing to the different types of country and vegetation which occur in this region, it might be

well to take this part by stages. From Kondundu to Kokaro the country consists of a large plateau, from which huge granitic bosses arise on all sides. The vegetation is scanty, and tall grass predominates. The following are the records for *G. palpalis* on this route :—(1) At Telebo on the River Buo, (2) at Kenewa on the River Mansai, (3) very abundant at the River Bafi, (4) at a stream near Beraia, (5) at the River Sangha near Kokaro. On the road from Kokaro to Ka Yima, the same species was obtained at :—(1) a small river near Bumbanya, (2) the River Sumunyi, and (3) Ka Yima. *Tabanus besti* var. *arbucklei* was also found at Bumbanya, and *Hippocentrum murphyi* at Ka Yima.

Between Ka Yima and Iamadu, the country is undulating, and this may be regarded as the southern end of the Loma Mountain region. The vegetation is scanty and grass predominates, except on the banks of rivers and streams, where there is heavy bush and high shady trees. Iamadu stands on the bank of the River Bafi. *Hippocentrum murphyi*, *Glossina palpalis*, and *Simulium damnosum* were found here. Never have I seen the last-named species in such enormous numbers ; they rose in black clouds from a small stream which runs into the River Bafi.

Between Iamadu and Jahama *Glossina fusca* was found in thick bush on a ridge which forms the watershed between the Rivers Bafi and Moa. *G. palpalis* was obtained shortly after the crossing of this ridge at the base of the Nimmini Mountains. The trek from Jahama to Panguma parallel with the Nimmini Mountains was very uninteresting. Only one blood-sucking insect was seen, namely, *G. palpalis* at the River Woa (a tributary of the Moa), north of Panguma. At Panguma itself, *Haemaphysalis leachi*, *Rhipicephalus sanguineus*, and *Ctenocephalus felis* were obtained from dogs.

At Hangha *G. palpalis* was found near the railway line, and on dogs, *H. leachi* and *Rhipicephalus simus* were abundant.

(4.) The Sierra Leone Government Railway.

This railway runs from Freetown to Pendembu, a distance of about 230 miles, in an almost easterly direction ; a branch line extends north-east from Boia Junction, 65 miles from Freetown, to Makump, where it crosses the Rokell River. The country through which the main line passes rises gradually from Freetown to the terminus ; there are extensive clearings on both sides of the line and numerous swamps are crossed ; in places oil palms are cultivated, but rice is the staple crop in the vicinity of the railway.

As has been shown elsewhere, the rivers of the Protectorate flow from north-east to south-west, and consequently the railway crosses them all, with the exception of the Great and the Little Skarsies and the Rokell. The Rivers Jong and the Bum or Sewa are navigable for large canoes at the height of the rains from the sea to the railway.

From Freetown, the line passes along the north-eastern side of the Peninsula at the foot of the Sierra Leone Mountains to Waterloo. Several ravines are crossed and the sides of the mountains are densely wooded ; here and there steep waterfalls occur in the ravines, and the general effect of picturesqueness and grandeur is characteristic of this part of the line.

Waterloo, the headquarters of the District Commissioner for the Colony, 20 miles from Freetown, is situated at the northern end of the isthmus which separates the Peninsula from the Protectorate. It stands at the head of a large creek which is navigable at high water from Freetown. The vegetation in and around the town is very dense, and mangroves predominate at the head of the creek, which is tidal to this point. The out-going tide leaves an extensive mud flat, and this combination is extremely favourable for the occurrence of *Glossina palpalis*. In addition to this species the only other blood-sucking fly caught there was *Tabanus fasciatus*.

At Newton, 25 miles from Freetown, no blood-sucking flies were seen, but one tick, *Haemaphysalis leachi* was found on a bush-shrike (*Dryoscopus turetii*) shot there. At Songo Town, on the river of that name, *Tabanus besti* and *T. fasciatus* were caught, while on the dogs *Rhipicephalus sanguineus* were abundant. Rotifunk stands on the River Bumpe, which is tidal to this point; there *G. palpalis*, *T. besti* var. *arbucklei* and one male specimen of the rare blood-sucking fly, *Thaumastocera akwa*, were obtained.

Moyamba, 76 miles from Freetown, is the headquarters of the District Commissioner and Medical Officer of the Ronietta District; it stands on the banks of the Yambuta River. *Glossina palpalis* is abundant near the river, and *G. fusca* in the more densely wooded part around. *Tabanus fasciatus* and *T. besti* var. *arbucklei* are also very prevalent, while the following mosquitos are common:—*Stegomyia fasciata*, *Culex decens*, *Eretmopodites chrysogaster*, and *Toxorhynchites brevipalpis*.

The town of Bo is probably the largest native town on the railway, but its chief importance lies in the fact that it is also a large railway centre, since all passenger trains upwards and downwards remain there overnight. It is the headquarters of the Puisne Judge of the Protectorate, the Medical Officer of the Railway District, and numerous railway officials. The undenominational school for the sons of chiefs is also situated here, and teachers belonging to this institution along with the representatives of the trading firms augment the European population. In addition to these Europeans permanently stationed there, one must not overlook the fact that there is a considerable floating population, for example, the engine-drivers, who, in the case of up-trains, remain one night at Pendembu and the next at Bo; and in the case of down-trains one night at Freetown, and the next at Bo, and so on. Further, there are the passengers both up and down, who are compelled to leave the train for the night and occupy quarters in the Government rest-house. Bo has, therefore, probably the largest and most constantly floating population in the Protectorate.

Much has already been done to ameliorate the conditions of life at Bo, but considerably more will have to be accomplished in the way of clearing and general upkeep, especially in the railway reserve, before the blood-sucking insect fauna can be reduced to such an extent as might be expected in so important a station. Mosquitos are troublesome in the quarters of the permanent officials, but a perfect pest in the Government rest-house.

This rest-house stands in the railway grounds. The clearing of the surrounding bush is far from adequate (Plate XIX, fig. 1), and the supervision necessary when one remembers that the occupants are for the most part

quartered there only from 6 p.m. to 6 a.m. on the following day is almost totally neglected. Consequently one finds all sorts of rubbish and water-holding receptacles, *e.g.*, empty tins, hidden in the grass around. To these and many similar water-collecting utensils seen in a scrap-iron heap attached to the railway workshops may be attributed the large number of mosquitos which invade the rest-house.

According to the Medical Officer in charge of Bo during my visit, the supervision of this area does not come under his jurisdiction, and certainly no one else takes any interest in the matter—a truly lamentable state of affairs which ought to be altered in justice to the health of the visitor who pays nightly for his quarters.

The predominant mosquito is *Anopheles costalis*, but *Toxorhynchites brevipalpis* is also common. *Glossina palpalis* is frequently seen here, but not in any great numbers, while numerous *Tabanus brumpti* have been caught in the bungalows around the light in the evenings. It is rather characteristic of this species, as well as of *T. subangustus*, that it is nocturnal in its habits and is attracted by light. *Stomoxys nigra* was found in the train at Blama, but whether it actually breeds there or was conveyed some distance by the train is not certain. *Tabanus kingsleyi* occurs at Kennema and *G. palpalis* on the south side of the railway from the station. At Hangha *G. palpalis* is common, and the dogs there were infested by *Haemaphysalis leachi* and *Rhipicephalus simus*, while at Segbwima, about 20 miles further on, *Tabanus pluto* was captured. At Baiima *G. palpalis*, *G. fusca*, and *T. besti* var. *arbucklei* were seen in numbers.

Daru, the headquarters of the Sierra Leone Battalion of the West African Frontier Force, is situated on the Moa River about 213 miles from Freetown. The cantonments lie in the angle formed by the railway and the river, but the native town is on the opposite side of the river about a mile further on. Some of the Officers' quarters are placed along the top of a bank overlooking the railway, but the others are situated on high ground along the river bank. The native lines are laid out in such a manner as to extend inward from the river bank some distance higher up than the European reserve.

Owing to the untiring efforts of Drs. Murphy and Powell the blood-sucking insect fauna of Daru is now very well known. Thanks, however, to the energy of these two Officers and Col. Newstead, the Officer Commanding the Battalion, the number of insects now seen is not commensurate with what might be expected from an examination of the list of species.

The following have been recorded from the immediate vicinity of the cantonments :—*Glossina palpalis*, *Stomoxys calcitrans*, *Tabanus pluto*, *T. ruficrus*, *T. fasciatus*, *T. besti*, *T. besti* var. *arbucklei*, *T. secedens*, *T. thoracinus*, *T. marmorosus*, *T. postacutus*, Aust., i.l.,* *Stegomyia fasciata*, *S. apicoargentea*, *Culex invidiosus*, *Eretmopodites chrysogaster*, *Ochlerotatus cumminsi*, and *Toxorhynchites brevipalpis*.

As may be surmised, *G. palpalis* and the various species of *Tabanus* are confined chiefly to the bank of the river, but, especially in the wet season, one

* [A description and figure of this new species will be published by Mr. Austen in the next part of this Bulletin.—Ed.]

and all of these invade the various officers' quarters and the mess. Mosquitos were very troublesome during my visit, and along with Dr. Powell I made a survey of the various parts where larvae might be expected. In the house kindly put at my disposal by the Officer Commanding during my stay in Daru, nearly all the species of mosquitos mentioned above were obtained, and this may be taken as typical of all the European quarters.

Larvae were found in various water-filled depressions in the soil, in hollows in trees, in the receptacle formed by the bases of the leaves of pineapples, in canoes at the river-side, in pools in the concrete floor of the verandahs of unoccupied houses, and in the bamboo fencing around the gardens kept by the native soldiers. The last-named of these was the most important. Bamboos were used for fencing purposes and no attention was paid to where these were cut; so that in nearly every pole several inches of the terminal internode formed a receptacle for water. In every one of these examined, larvae were found, and in almost every case *S. fasciata* and *S. apicoargentea* were bred out. Three remedies for this unfortunate and dangerous state of affairs suggest themselves:—(1) to discontinue the use of bamboo for fencing purposes; (2) if bamboo must be used, to see that all the tops are carefully trimmed off immediately above the node; or, (3) to split the bamboo for some distance from the top.

The third of these is not very satisfactory, but it was the method adopted with the existing fences at Daru owing to its being impossible to uproot all the fencing at that time. It can be looked upon, however, as only a temporary measure, but Col. Newstead, when this state of affairs was pointed out to him, very willingly agreed to discontinue the use of bamboos for fencing at the earliest opportunity.

Of equally great importance and of a more permanent character is the question of extensive clearing around the cantonments. Dense bush extends from the railway line to the fencing around the various officers' compounds on the one side, and from the river bank to the compounds on the other. There can be no question that this whole area should be absolutely denuded of all vegetation, as the ground, being very uneven, contains many water pools in the wet season, and is a favourite dumping ground for all sorts of tins and rubbish by careless servants.

As pointed out to me both by the Medical Officer and the Officer Commanding the Battalion, the sanitary gang, as at present constituted, is totally inadequate for undertaking new work such as this; in fact, it has more than enough to do to keep the station as it exists at present in anything like a sanitary condition. Certainly some special effort should be made on the part of the sanitary authorities to establish and maintain in the first instance such a clearing as that mentioned, in order to abolish, so far as possible, the scourge of mosquitos and other blood-sucking insects from a station where so many white officials are constantly resident and in close contact with native troops.

At Baiima, a few miles further up the railway, *Glossina palpalis*, *G. fusca* and *Tabanus besti* var. *arbucklei* were found, while at Pendembu *G. palpalis* and a new species of *Tabanus* were the only blood-sucking insects seen.

As has been said, a branch line runs in a north-easterly direction from Boia Junction, 64 miles from Freetown, to Makump on the Rokell River. It passes

through Ronietta, Roruks, Yonnibanna, and Makump, thence across the Rokell River, and thus taps the oil palm country in the north of the Ronietta district, the Karene and Kaballa districts. At Makump is situated the large experimental factory established by Lever Brothers for the extraction of oil from the fruit. Consequently, this railway is destined to be one of the most important trade routes of the Protectorate, and as such should be duly regarded as a means for the spread of blood-sucking insects and of the dissemination of the diseases transmitted by them.

The following notes will serve to show what insects have so far been found and the localities at which they were taken.

At Ronietta, only *Glossina palpalis* was found, but between that station and Yonnibanna this species was obtained at several places, in addition to *G. fusca*, while the same is true of the road between Yonnibanna, Kumrabai and Mayosso (*see* map). At Mayosso, *G. palpalis* was abundant on the Pampana or Taia River and also in the houses in the town. *Tabanus secedens* was also obtained there. At Makump, on the River Rokell, *G. palpalis* was a perfect scourge, and in the thicker bush around *G. fusca* was common. In addition to these, *Haematopota* sp. n. and *Stegomyia fasciata* both occur in the native town, the latter in considerable numbers.

It must be pointed out that in this brief survey of the railway only a few of the most important stations were examined, and consequently the enumeration of the species given may by no means exhaust the various types which may occur at other places. Further, it cannot be said that the list given for the places examined are complete, as at other times of the year different species may occur. The systematic examination of the blood-sucking insect fauna of the various places on a railway ought not to be confined to the enumeration of the species which occur at the various stations and the elimination of these from such stations, but should be of a more searching character.

The rôle played by trains in transferring insects from one locality to another cannot be overlooked, so that the regions between stations are equally important in this respect, and too much attention cannot be paid to the nature of the clearings on the banks of streams and such-like, and to the drainage of borrow-pits, for these last, unless properly looked after, are invariably foci for the dissemination of mosquitos. It is well known that tsetse, TABANIDAE, and mosquitos are often carried long distances in trains and motor waggons, and may thereby be introduced with disastrous results into areas where they were previously unknown. Only one example of this need be cited, namely, in Accra, which was free from tsetse up to the time of the construction of the railway through a fly-belt. Now these insects are by no means uncommon, and it only remains to be seen whether they will permanently establish themselves there. Whether they do so or not, their presence is even now a serious menace to the existence of horses in that town.

(5.) Daru Sub-District.

This sub-district was traversed between 1st and 17th August with a view to an enquiry into the conditions which obtained in the out-stations of the West African Frontier Force with regard to blood-sucking insects. Two of these

stations, namely Kailahun and Dodo, which until last year formed part of Liberia, were visited, but the inspection of another, namely Tisani, which is further north, did not justify the time involved, as the Medical Officer in charge there had already made a small collection of such insects. These include the following:—*Glossina palpalis*, *Hippocentrum trimaculatum*, *Tabanus ruficrus*, *T. besti* var. *arbucklei*, *T. postacutus*, Aust. i. l., and two new species of *Haematopota*.

From Pendembu, the railway terminus, a wide, well-made road has been constructed to Kailahun (Kanre Lahun); no blood-sucking insects were seen along this road nor were any found at the station. One company of the West African Frontier Force is quartered there; the country is open and the lines well laid out on high-lying ground.

The next station visited was Dodo, and halts were made at Sandyallu and Kengama. The road to Sandyallu is very hilly and is surrounded by dense bush; the valleys for the most part contain extensive swamps, where *Hippocentrum trimaculatum* was abundant; in fact, this is the predominant species in such places in West Africa. In Sandyallu itself, the following species were caught:—*Tabanus besti* and var. *arbucklei*, *Haematopota* sp. n., *Ceratopogon* sp. and *Simulium damnosum*; the last-named species was very troublesome at the river-side, and *Ceratopogon* was abundant in the native houses. *Auchmeromyia luteola* was also seen in numbers in the native town.

The country between Sandyallu and Kengama consists of large rounded granitic hills, bare or covered with grass; the valleys are clothed either with grass or dense bush. The only blood-sucking fly seen during this trek was *Chrysops longicornis*. The eyes of this species are remarkable in their colouring. The ground colour is metallic emerald green, but along the upper margin there is a stripe of metallic coppery brown, while in the centre of the eye there is also an irregular but definite area of the latter colour.

Dodo is also an out-station of the West African Frontier Force; it stands on the River Keya, a tributary of the Mauwa, which eventually joins the Moa north of Daru. *Glossina palpalis* is by no means uncommon along this stream, and *Stomoxys calcitrans* frequents the town. It may be noted that cattle are kept there. *Auchmeromyia luteola* was also caught at Dodo, but the natives did not know of the floor maggot.

From Dodo to Giema the country is moderately open; at Giema *G. palpalis*, *Stomoxys calcitrans*, *Tabanus besti*, and var. *arbucklei* were obtained. Onwards from Giema to Gondema the country was more hilly and very heavily wooded. *Glossina fusca* was caught at several places between these two towns and also at the latter. Between Gondema and Bomaru the River Mauwa had to be crossed, and there *G. palpalis* was found. At Bomaru the only blood-sucking fly seen was *Tabanus besti* var. *arbucklei*. From Bomaru to Baiima, on the railway, the country is densely wooded and there are numerous small rivers and swamps. *G. palpalis* was very abundant at a moderately large river near Baiima, and *G. fusca* was obtained in the more heavily wooded parts on the road. At Baiima itself *G. fusca* and *T. besti* var. *arbucklei* were caught.

The country now to be described lies to the west of the Moa River, and a start was again made from Pendembu. Between this town and Manawa the

River Moa had to be crossed by canoe. At this part the river is wide and swiftly flowing, and there is a large island in the centre. While my loads were being carried across this island, *G. palpalis* constantly attacked the carriers, and the same species was troublesome at Manawa. From Manawa to Komatendu the road is hilly and runs parallel to the River Moa ; at one place it passes close to the junction of this river with the Meli. The country is densely wooded, and *Glossina fusca* is by no means uncommon. At Komatendu a new species of *Tabanus* was caught, along with *T. besti* var. *arbucklei*. *Auchmeromyia luteola* was also obtained in the native town.

On a mongoose (*Mongos paludinosus*) several ticks were found ; these according to Professor Nuttall are "apparently *Haemaphysalis leachi*, but not typical, being much shortened." A new species of *Ixodes* was also taken from the same host, while the lungs contained several specimens of *Porocephalus* sp.

Between Komatendu and Bendu the country is extremely hilly, and part of the watershed between the Rivers Moa and Male has to be crossed. The hills are heavily clothed with small trees and thick undergrowth, and *Glossina fusca* may be caught at almost any part of this region. The same species occurs at Bendu. From Bendu to Bunbumbo the road runs nearly parallel to the River Male, the country being fairly level. Several *G. palpalis* were caught at the River Loya, a tributary of the Male, near Bunbumbo. *Stomoxys calcitrans* was also common at Bunbumbo. A well-made wide road runs from there to Segbwima, on the railway ; no blood-sucking insects were seen during this stage, but *Tabanus pluto* was caught at the town of Segbwima.

(6.) Daru to Bo, *via* Bandasuma.

The region now to be described lies south of the railway, and the route traversed crosses three distinct river systems. From Daru to Bandasuma the basin of the River Moa is followed, roughly parallel to the river. At Bandasuma the River Moa is crossed, and the road then passes over the low watershed which separates the Moa from the Kittam River ; this last-named takes its origin south of the railway and flows almost due south into Lake Kassa, part of the lagoon which separates Turner's Peninsula from the mainland. At Largo this river is crossed, and near Tikonko the Bum or Sewa is again encountered ; the river basin of the latter is followed until Bo is reached.

The country between Daru and Juru is mostly level in the parts traversed by the road, but hilly to the east and north-east. These hills form the watershed between the Rivers Moa and Morro ; they are forest-clad, but the level country is covered with short bush and is much under rice cultivation.

The first town at which a halt was made was Jowati, which stands at the confluence of two small streams which run into the River Moa. There *Glossina palpalis* and *T. besti* var. *arbucklei* were both found in numbers, and from larvae obtained in a "ju-ju" basin on a grave *Stegomyia fasciata* was bred out. It is worthy of note that from one of the *Glossina* caught here a semi-deposited pupa of a pale golden yellow colour protruded ; the date was 19th August.

No blood-sucking flies were seen between Jowati and Mendikama, but at the latter town both *G. palpalis* and *T. besti* var. *arbucklei* were caught. Between

Mendikama and Juru the country is more hilly and covered with thick forest growth. *Glossina fusca* was common, and near swampy places and streams on the road *G. palpalis* occurred; *Stomoxys calcitrans* and a new species of *Tabanus* were caught in the town. From Juru to Bandasuma the road passes through thickly forested country, and the predominant species obtained was *Glossina fusca.* Reference to the map will show where these were obtained, so that it is unnecessary to detail each locality here. *G. palpalis* and *Tabanus thoracinus* were also caught near Gigbema.

Bandasuma is a very large town, well laid out and very clean, situated on the bank of the River Moa (Plate XIX, fig. 2). Extensive clearings have been made for farming purposes and it says much for the way the town is looked after that only a very few specimens of *G. palpalis* were seen and no other blood-sucking flies were encountered.

Between Bandasuma and Falaba (2)* the country is forest-clad, and *Glossina fusca* was again plentiful all along the route. Falaba is a small town on a tributary of the River Moa. The following blood-sucking flies were obtained there:—*Glossina palpalis, Chrysops longicornis, Culex tigripes* var. *fuscus, Culex pruina,* and *Simulium damnosum*; the last-named was very troublesome.

Towards Bumpe, about half-way to Bandajuma, *Glossina fusca* was again met with, but after that point the country is much more open. Bandajuma was the old headquarters of the Sherbro District, but these are now removed to Pujehun. It will still, however, remain an important town owing to the fact that it is to be one of the new outposts of the West African Frontier Force. It is situated on the River Wanje, a tributary of the Kittam River; *G. palpalis* was the only blood-sucking fly seen there.

From Bandajuma to Sembehun the country is again well forested, and *Glossina fusca* was found at two places (*see* map). At Sembehun, on the River Yano, which runs into the Bum or Sewa not far from this point *G. palpalis* and *Simulium damnosum* were abundant, the latter in large numbers. The Bum River has to be crossed between Sembehun and Tikonko; there *G. palpalis* was caught; while at Tikonko the same species, *Toxorhynchites brevipalpis* and *Simulium damnosum* were also obtained. The forest in this region gives way to thick bush, while between Tikonko and Bo oil palms are frequent and extensive clearings have been made for cultivation.

(7.) Bo to Moyamba, *via* Tungea and Makump.

The region now to be described lies for the most part in the basin of the River Jong, but part of it also in that of the Bum or Sewa. It was traversed between the 19th and the 25th September; reference to the map will show the circuitous nature of the route.

From Bo to Dumballa the country is slightly hilly; thick bush predominates, but grassy knolls occur in many places. The only blood-sucking fly seen there was *Glossina palpalis* at the town of Dumballa on the River Tabe, which flows southward and enters the Bum north of Mafwe.

* To avoid confusion between this town and the other of the same name near Kaballa, I have added the numeral (2) after it.

Between Dumballa and Goraun the country is hilly and forms part of the watershed between the Rivers Bum and Jong. Goraun stands on the River Lia or Jaya, which flows into the Taia, which further on becomes the Jong. No blood-sucking flies were seen there. At a small town called Kennema a pony in good condition with no signs of trypanosomiasis infection was seen.

From Goraun to Jarra the road passes along the bank of the River Lia for the first part, and after that crosses numerous streams which run into the Bum The country is composed of low rounded hills which are for the most part covered. with grass with very little bush. Evidently the whole of this district is devastated annually by fire in the dry season. At Jarra *Tabanus ruficrus* and *Simulium damnosum* were caught.

Between Jarra and Gendema, a small town situated on the bank of the Sewa River, the road is undulating and numerous swamps and streams have to be crossed. At Jagbwima, where the River Sewa is first encountered, *Glossina palpalis* is common, and this species is to be found all along the river bank to Gendema. At the latter town *G. palpalis* was found along with *T. ruficrus*, *T. besti* var. *arbucklei*, and *T. postacutus*, Aust. i. l.

From Gendema to Kamboma the country consists of low rounded hills covered with grass and low bush; large granitic bosses occur in parts and there is abundant cultivation. This area is extensively burnt in the dry season. No blood-sucking insects were seen during this trek, and the only species obtained at Kamboma was *Simulium damnosum*.

Onwards from Kamboma to Tungea the country is more thickly covered with bush, and there are numerous swamps in the valleys. *Glossina fusca* was captured in the thick bush, and *Hippocentrum murphyi* in the swampy places where there was dense shade. The last-named species had not been described at the time of capture, and extended notes were made by the writer, but since then Austen has named it, and given a long specific description* from specimens caught by Dr. Murphy. It is unnecessary to quote my notes in full, but the following observations will supplement the description given by Austen. *Descriptive* :—The eyes of this species when alive are of a dull bronze green, and are traversed by four yellow horizontal zig-zag bands. *Habits* :—It is the most vicious biter yet encountered by the writer; in its mode and determination of attack it reminds one more of an infuriated wasp than a Tabanid; its dart is sudden and it seems to insert its proboscis before it actually alights. It appears to prefer shady places similar to those in which *G. palpalis* is found, but especially in the vicinity of swamps.

At Tungea in addition to *Glossina fusca*, *T. besti* var. *arbucklei* was caught. Between Tungea and Bewama the country is hilly and several swamps have to be crossed; it is covered for the most part with thick bush but is forest-like in places. In the more densely-shaded portions *Glossina fusca* is found, while in similar situations near the swamps *Hippocentrum murphyi* is common. At Bewama *G. palpalis* was caught on a small stream, a tributary of the River Taia, and in the town itself *T. besti* var. *arbucklei* and *T. postacutus*, Aust., i.l., were obtained. A species of *Amblyomma* was found on grass.

* Bull. Ent. Res. iii, pp. 135-6.

The road from Bewama to Mongheri crosses the River Taia at Jagbara and after striking across a bend re-crosses this river before Mongheri. *G. palpalis* and *H. murphyi* were found at Jagbara, and the same two species also occur at Mongheri. *Ceratopogon* sp. was also troublesome at the latter place. Between Mongheri and Yele the road skirts the southern end of the Kagnari Mountains, practically follows the right bank of the River Taia, and crosses several large tributaries of this river. *G. palpalis* was seen at several of these and also at Yele on the River Taia. Where the road runs near the mountains, which are densely clothed with thick forest, *G. fusca* was caught, while at Yele *Tabanus ruficrus* was obtained, and at a swamp near that town *H. murphyi* was captured. From Yele to Makump the road runs along the western side of the Kagnari Mountains and afterwards skirts the base of the Masamanka Hills. The whole country is densely wooded, and *Glossina fusca* is to be found almost everywhere (*see* map).

Between Yele and Mayeppa *G. palpalis* was caught on a stream near Dumballa, and further on again on the River Kanasi between Mayeppa and Matotaka. At the latter place *Eretmopodites chrysogaster* was bred from larvae taken from a calabash used as a "juju-" or "medicine-pot," and *Hippocentrum murphyi* were found near a swamp at the same place. The country between Matotaka and Makump is thickly covered with oil palms and there are numerous swamps. The River Pampana, or Sanden, or Taia, or Jong, is crossed not far from Matotaka. The town of Makump stands on the bank of the Rokell River, aud on both these rivers *G. palpalis* occurs in large numbers, while in the heavily-forested region between them *G. fusca* is abundant. At Makump, in addition to *G. palpalis*, *Stegomyia fasciata* and a new species of *Haematopota* were obtained.

The region between Makump and Yonnibanna has been described by the writer when discussing the branch railway (*see* p.). Between Yonnibanna and Moyamba the only blood-sucking insects seen were *G. fusca*, near the town of Bambama, and *G. palpalis* at that town.

(8.) Moyamba to Bonthe, Subu, Mafwe, Mattru and Rotifunk.

Moyamba to Bonthe. This is the direct line of communication between Freetown and Bonthe and is the route by which the mails are carried. The first part, namely from Moyamba to Sembehun, is accomplished by road; the second part, Sembehun to Bonthe, by rowing boat down the Sembehun creek. A well-made road connects Moyamba and Sembehun through a densely-wooded country. *Glossina fusca* occurs at several places on this road.

Sembehun is an important town standing at the head of a long creek of the same name; its importance is due to the fact that the tidal influence ends there and canoes cannot ascend any further. Consequently it is a sort of loading and unloading inland-port for Bonthe. It is surrounded by mangrove swamp which is uncovered when the tide is out. *G. palpalis* is everywhere to be seen, and *T. besti* var. *arbucklei* is not uncommon.

The whole creek with its mangrove swamp is characteristic of all tidal reaches in West Africa. As far down as Yorke there are patches of higher land, and

there one sees small fishing villages, but beyond this town the whole area is under water at high tide in the rains, and the only signs of human habitation are a few fishing huts used during the dry season. Near Bonthe this creek is divided in two by Sherbro Island and opens into the sea east and west of this island. *G. palpalis* is everywhere abundant along the creek and *Tabanus fasciatus* and *T. besti* var. *arbucklei* are far from uncommon; *T. postacutus* was also found near Yorke.

Bonthe, as has already been stated, is an important port for ocean-going cargo steamers. It stands on Sherbro Island, is well protected from the sea, and is surrounded by mangrove swamp. A great amount of reclamation has been done and work of a sanitary nature is being constantly pushed forward. Clearing and effective sanitary measures have done much in recent years to diminish the number of *Glossina palpalis* which formerly must have swarmed over the whole area. The two most troublesome mosquitos are *Anopheles costalis* and *Stegomyia fasciata*, but according to Dr. Orpen, who was stationed there during my visit, these have also been greatly reduced in numbers in the last few years.

The journey from Bonthe to Subu was accomplished in rowing boats along the lagoon which separates Turner's Peninsula from the mainland. Owing to the large amount of fresh water which is constantly being poured into the lagoon by the Bum River, the water is brackish only for a very short distance from Bonthe, and consequently the mangrove area is very limited in this direction. This is gradually replaced by grass, palms, and generally shrubby vegetation. The shores are very low-lying and swampy (Plate XX, fig. 1). *Glossina palpalis* was caught at several places between Bonthe and Muchaj, and at the latter place *Anopheles costalis* and *Mansonioides uniformis* were troublesome.

Between Muchaj and Kattin the shores are again low-lying and swampy and are covered for the most part with grass, but here and there clusters of oil palms and bush are to be seen. *G. palpalis* was caught at Bap and Kattin and probably occurs in many more places in this reach. *Tabanus fasciatus* and *T. taeniola* were also found at Kattin, while in the bush behind this town *Anopheles mauritianus* occurred in numbers. Between Kattin and Subu there are many small villages which are high and dry during the dry season, but which are almost completely submerged in the rains (Plate XX, fig. 2); miles of grass land are similarly under water in the rainy season. The town of Subu is situated on Turner's Peninsula to the south-east of the mouth of the Bum or Sewa River. *G. palpalis* was obtained there and *T. fasciatus* was caught at several places between Kattin and Subu.

The town of Mafwe stands on the Bum River, about 50 miles from its mouth; to this point the writer ascended in a rowing boat. The banks on the lower part of the river as far up as Torma are similar to those in the lagoon and are covered with grass, with occasional stretches of overhanging bush. Near Gori the grass diminishes in amount and is eventually replaced by tall overhanging trees and dense undergrowth (Plate XXII, fig. 1). It may be taken as a fair guide to the distribution of *Glossina palpalis* in this region if one says that wherever bush occurs there that species will be found, but seldom, or never, where grass predominates. The same may said of *Tabanus fasciatus*.

Torma will long remain a vivid memory in the mind of the writer on account of its mosquitos. His experience there was certainly the worst he ever encountered with these troublesome insects. As soon as the sun had set, they began to invade the rest-house and work was impossible. So numerous were they and so blood-thirsty that the process of undressing had to be conducted outside. By some means or other a few managed to win their way inside the mosquito net, and to remain in bed was simply courting disaster. Finally, my dog, which was chained to the bed, became restive and I had to get up and loose him. He made one rush for the door and did not return for hours, which was far from his usual habit. To return to bed was now impossible, and I was being bitten in every available spot. I counted over 300 on one side of my mosquito net at one time and in about twenty minutes I caught and chloroformed over 80 in glass-bottomed boxes. The buzzing noise emitted by the remainder could be heard many yards from the house. The rest of the night was spent in the open, and dressing in the morning was accomplished outside. The servants who were quartered in the town complained bitterly of their troubles with mosquitos during the night. On examination the following species were identified :—*Anopheles mauritianus*, *A. costalis*, *Mansoniodes uniformis*, and *M. africanus*, and it is more than probable that all these species occur in all the towns along the lagoon and on the river.

G. palpalis was caught at Gori and at several places between Demaboa and Mafwe, while *Tabanus fasciatus* was abundant all along the river. At Mafwe *T. fasciatus* and *T. besti* var. *arbucklei* were caught in a house in the town. Several specimens of *Porocephalus* sp. were obtained from a snake (*Naia albicollis*), four feet long, shot in the river.

The remainder of the journey to Rotifunk was accomplished overland. Between Mafwe and Mattru *T. fasciatus* and *T. besti* var. *arbucklei* were both caught on the road. Mattru is a large town on the Jong River at the limit of navigability for large boats from Bonthe. The following blood-sucking insects were obtained there :—*Glossina palpalis*, *Tabanus fasciatus*, *T. besti*, *T. besti* var *arbucklei*, *Haematopota* sp. *Anopheles costalis*, *A. mauritianus*, *Mansonioides uniformis* and *M. africanus.*

The country from Mattru to Gbangbama is undulating and covered with low thick scrub (Plate XXI, figs. 1 and 2). *Tabanus fasciatus* was the only blood-sucking insect seen during this trek, but at Gbangbama *Glossina fusca* was obtained. A lizard (*Agama colonorum*) was caught there and found to be infested with a red ecto-parasite belonging to the genus *Geckobia*, of which hitherto only one species, namely, *neumanni*, has been described.

Gbangbama is the headquarters of a sub-district of Sherbro where an Assistant District Commissioner is permanently stationed. At the time of my visit a company of the West African Frontier Force was quartered there and considerable clearing had been effected for the erection of military lines and a large prison (Plate XXI, fig. 2).

The road from Gbangbama to Sembehun crosses numerous rivers and creeks at the limit of tidal influence, or in other words, at the extreme northern limit of mangrove swamp. At all these places *G. palpalis* was found. It is unnecessary to give these localities in detail, as all are recorded on the map. *Tabanus besti* was the only other blood-sucking insect seen during this trek.

Between Sembehun and Senahu the country is fairly level, swampy in places, and covered with low bush. At Senahu the following were caught :—*G. palpalis*, *T. fasciatus*, *T. besti* var. *arbucklei*, and a new species of *Haematopota*.

From Senahu to Rotifunk (on the railway) the country is undulating and is covered with low bush with abundant oil-palms. *G. palpalis* was caught at the River Male, and *T. besti* var. *arbucklei* not far from Rotifunk. At this town one male specimen of *Thaumastocera akwa*, a very rare species, was obtained. The following note on the colour of the eyes in the fresh specimen was made at the time of capture. "The upper two-thirds of the eyes is yellow with irregular bronze spots, while in the lower third the pattern is the same but the colours are reversed ; in both cases the spots are irregularly disposed."

(9.) Rotifunk to Waterloo *via* Rokell.

Rotifunk stands on a small river, the Bumpe, which joins the River Walle, on which Senahu is situated, before it enters the sea. From Rotifunk to Robarri the country is undulating and covered with low thick scrub ; there are extensive clearings for cultivation and numerous swamps. All along this road *Tabanus besti* var. *arbucklei* was plentiful. At Robarri, which stands on the Ribbi River, the vegetation is much thicker and continues so to Rokell. *Glossina fusca* was caught at several places in this region, along with *T. besti* var *arbucklei*.

Rokell is situated on the left bank of the river of the same name, opposite the town of Mabile. Large canoes ascend from the sea to this town, but although the tidal influence is felt there, it is not brackish water and consequently there are no mangroves. *G. palpalis* is to be found all along the river banks, and *T. besti* var. *arbucklei* is very common.

Between Rokell and Ropat the road follows the river for the greater part of the way at varying distances from it. The same two species mentioned above were caught there, but in addition to these *Tabanus fasciatus* was also seen. From Ropat to Songo Town the country is covered with low bush and there is abundant cultivation. *T. besti* var. *arbucklei* and *T. fasciatus* were both plentiful along this road.

At Songo Town *Rhipicephalus sanguineus* was found on dogs, and at Newton Station *Haemaphysalis leachi* was taken from a bush-shrike (*Dryoscopus turetii*) shot there. The road from Songo Town to Waterloo follows the railway ; at the latter town *G. palpalis* and *T. fasciatus* were obtained.

(10.) The Peninsula :—Waterloo to Freetown, *via* Kent.

The road from Waterloo to Kent, which is situated at the extreme south-east point of the Peninsula, passes along the base of the mountains from which Sierra Leone takes its name. With the exception of *G. palpalis* at Kent no blood-sucking flies were seen on this trek.

A visit was made to a small group of islands known as the Banana Islands, which form a continuation of the Peninsula ; there are only two towns of any size on these islands, namely, Dublin (Plate XXII, fig. 2) and Ricketts ; *G. palpalis* was found to be common along the beach and in both these towns.

A road runs from Kent to Freetown along the coast, and on it are situated several large and important towns, the chief of which are York and Hamilton. Several creeks surrounded by mangrove swamp have to be crossed by canoe, and at all of these *G. palpalis* was abundant. Reference to the map will show some of the places at which captures were made.

(11.) Freetown.

Freetown has always had a bad reputation for mosquitos, but thanks to the efforts of the Sanitary Department this stigma may now be partly withdrawn. In 1911, Dr. D. Alexander took over the duties of Sanitary Officer for Freetown and directed all his energies to the almost herculean task of abolishing these insect pests. By means of a careful and systematic examination of the various compounds and by a rigorous application of the mosquito ordinance, which makes the presence of mosquito larvae in any compound a punishable offence, the natives have been made more careful as to the water-containing receptacles in their preserves. This work was carried on in the face of great opposition on the part of the natives, and it will have to be continued in the same stringent manner for some time to come if the benefit already achieved is to be maintained and augmented.

At my suggestion, Dr. Alexander kept and bred out some of the larvae taken during his inspection, and also preserved many other sets of larvae which he had collected as evidence in criminal charges. It is unnecessary to give the details of the nature of the various receptacles in which these larvae were found, as the most of them are now well known, nor would it serve any useful purpose to give the exact localities where these were found, but it might be well to point out the types of mosquito found in Freetown.

By far the commonest and most widely distributed is *Stegomyia fasciata*; it may safely be said that this species bred out from over 90 per cent. of the samples taken. The other species found include :—*Stegomyia sugens*, *Anopheles costalis*, *A. funestus*, *Culex duttoni*, *C. invidiosus*, *C. decens*, and *Culiciomyia nebulosa*.

An examination of the area at Cline Town, which belongs to the Government Railway, made by the writer along with Dr. Alexander, revealed a most deplorable state of affairs. Lying about all over the compound were iron and other utensils not in use, which served to hold small quantities of water. In every collection of water examined mosquito larvae were found, and in every case *Stegomyia fasciata* bred out from these. It should be borne in mind that all water-holding vessels should be examined and emptied regularly, as one can never be sure under what conditions *Stegomyia* may breed, *e.g.*, the water which was kept in the barrels used in the blacksmith's shop for cooling red-hot iron, and which must necessarily become fairly warm at times, was found to contain larvae. Materials used in railway construction, when piled up, in most cases formed suitable places for the breeding of mosquitos, and if such is to be avoided there is only one solution, namely, the storing of these under water-tight roofs.

Apart from mosquitos, blood-sucking flies are practically unknown in Freetown. *Glossina palpalis* occurs around Wilberforce and Hill Station and I have also

seen this species at Mirimar and Cline Town. One specimen of *Thaumastocera akwa* was caught by Dr. Kennan, in March, 1909, near a lamp at night in a house in Freetown.

IV. Records of Blood-Sucking Insects and other Arthropods from Sierra Leone.

The various blood-sucking insects and other arthropods which have been found in Sierra Leone have been referred to in different places in the Narrative, but it has been thought advisable to collect these and place them in tabular form. This list, however, cannot be regarded as complete, as a large number of specimens collected by the author still await identification, and a considerable number of these will undoubtedly prove to be new. It will be seen from the following list that quite a number of species have been recently recorded from Sierra Leone for the first time, and there can be little doubt that several more still remain to be discovered.

The distribution records of the various species are very scanty, and it is to be hoped that those whose inclinations turn that way will collect each and every species, and by keeping exact data help in mapping out the distribution areas of the different genera and species.

Order DIPTERA.

Family Culicidae.

Anopheles costalis, Lw.
„ *funestus*, Giles.
„ *mauritianus*, Grp.
Culex decens, Theo.
„ *duttoni*, Theo.
„ *invidiosus*, Theo.
„ *pruina*, Theo.
„ *tigripes*, Gr. var. *fuscus*, Theo.
Culiciomyia nebulosa, Theo.
Eretmopodites chrysogaster, Grah.
Mansonioides africanus, Theo.
„ *uniformis*, Theo.
Ochlerotatus cumminsi, Theo.
Stegomyia apicoargentea, Theo.
„ *fasciata*, F.
„ *sugens*, Wied.
Toxorhynchites brevipalpis, Theo.

Family Tabanidae.

Chrysops longicornis, Macq.
Haematopota cordigera, Bigot.
„ *grahami*, Aust.
„ *lacessens*, Aust.
Hippocentrum trimaculatum, Newst.
„ *murphyi*, Aust.
Rhinomyza stimulans, Aust.
Tabanus argenteus, Surc.
„ *besti*, Surc.
„ „ var. *arbucklei*, Aust.
„ *brumpti*, Surc.
„ *congoiensis*, Ric.
„ *fasciatus*, F.
„ *kingsleyi*, Ric.
„ *laverani*, Surc.
Tabanus marmorosus, Surc.
„ *obscurefumatus*, Surc.
„ *obscurissimus*, Ric.
„ *par*, Walk.
„ *pertinens*, Aust.
„ *pluto*, Walk.
„ *postacutus*, Aust. i.l.
„ *quadrisignatus*, Ric.
„ *ruficrus*, P. de B.
„ *secedens*, Walk.
„ *socialis*, Walk.
„ *subangustus*, Ric.
„ *taeniola*, P. de B.
„ *thoracinus*, P. de B.
Thaumastocera akwa, Grünb.

Family Muscidae.

Glossina fusca, Walk.
„ *longipalpis*, Wied.
„ *palpalis*, Rob. Desv.
Stomoxys calcitrans, L.
„ *nigra*, Macq.

Family Chironomidae.

Ceratopogon sp.

Family Simuliidae.

Simulium damnosum, Theo.

Order SIPHONAPTERA.

Family PULICIDAE.

Ctenocephalus canis, Curtis.
Ctenocephalus felis, Bouché.

Family SARCOPSYLLIDAE.

Dermatophilus penetrans, L.

Order ACARI.

Family IXODIDAE.

Amblyomma splendidum, Giebel.
" *tholloni*, Neum.
" *variegatum*, F.
Boophilus australis, Fuller.
Dermacentor circumguttatus, Neum.
Haemaphysalis leachi, Aud.
" *parmata*, Neum.
Ixodes sp.
Rhipicephalus sanguineus, Latr.
" *simus*, Koch.

V. VOCABULARY OF NATIVE NAMES FOR INSECTS.

The compilation of a vocabulary of native names for any group of animals is beset with many difficulties, and in the case of insects this is still more pronounced, inasmuch as these names are seldom or never given to the insects after handling or examination, but nearly always during their flight or when they have settled down and are biting or have already bitten. Consequently, one often finds that a single name may be applied to very diverse species or even genera of insects.

On the other hand, native names often give a clue to the bionomics of certain insects based on the observations of the natives. Consequently, I tried to obtain as many names as possible from the various tribes with whom I came in contact in Sierra Leone. By so doing the interest of the natives themselves was aroused, and one was able to make a start at instruction as to the dangerous nature of such insects, their methods of breeding, their habitats, and so on—a subject which is well worthy of the attention of the travelling medical officer.

It is not claimed for the following table that it is complete or correct in every detail, and the author will be grateful for any additions or corrections. The explanations given in the footnotes to the table are set down just as given to me by my interpreter in his own quaint manner of speaking; the identification of the genera and the species was made from an examination of actual specimens of these by the natives.

Name of Tribe.	MENDI.	TIMMANI.	KONNOH.	LIMBA.	KORANKO.	SUSU.	YALLUNKA.	FULA.
Sandfly ...	Moie	Mutumut[3] / Mapulut[4].	Muri	Mumuti[3] / Bono	Tumfia	Murumuntungi. / Moriki ...	Tumfia...	—
Mosquito.	Pundi ...	Emis[5] ...	Pundi ...	Sumusi[5]...	Susi[5] ...	Sasi ...	Sasina[5] ...	Susuli.
Tsetse ...	Folleli[1] ...	Kapup ...	Yoli ...	Folloi[7] ...	Joli ...	Heri ...	Chairena..	Luli.
Large Tabanid.	Kalloi[2] ...	Obuk ...	Site[6] ...	Nakabariki.[8]	Sigitega...	Siki ...	Sigitegina[9]	Kurubabi.
Small Tabanid.	Kalloi ...	Fott ...	Ywalli...	Mapetu ...	Sigitega...	Siki ...	Sigitegina	—
Flea ...	Bavi	Rusum ... / Atur ...	Bafi ...	Merentem	Murc ...	Kari ...	Merentem	—
Jigger ...	Jigger ..	Jigger ...	Jigger ...	Jigger ...	Tumbe ...	Kuli ...	Jigger ...	Jigger.
Tick ...	Nyari ...	Amof ...	Doe ...	Dani ...	Doe ...	Doi ...	Duena ...	Koti.
Bed bug ..	Bingbeyawi.	Trolong...	Pambatala.	Bubuduni	Sambakori.	Kuguri ...	—	—

(1) = "Black fly"; (2) = "Cut like a knife"; (3) = *Ceratopogon*; (4) = *Simulium*; (5) = "No let sleep"; (6) = *Tabanus pluto*; (7) = "Softly-softly biter"; (8) = "Quick Biter"; (9) = "Follow bush-cow" (Sigi = bush-cow).

VI. Insect-borne Diseases in Man and other Animals.

Malaria.

As in all West African Colonies, this is by far the most prevalent insect-borne disease. Sub-tertian infections are most frequent, but benign tertian and quartan are far from uncommon. Of recent years, however, the number of cases has been gradually diminishing, owing in great part to the almost universal use of quinine as a prophylactic, the more prevalent use of mosquito nets and mosquito-proof rooms, the segregation of European quarters, and the sanitary measures adopted for the diminution of the number of mosquitos.

Practically nothing is known with regard to the species of mosquitos which are implicated in the transmission of the disease, but it is more than probable that *Anopheles funestus* and *A. costalis* are the principal culprits.

The number of *recorded* deaths from malaria from 1906–1909 are as follows :—
1906, 118 ; 1907, 202 ; 1908, 150 ; 1909, 119.

The malarial index has been worked out for a number of towns in the colony, and the following are the percentages found :—Kent, 80 ; Tombo, 76 ; Waterloo, 69 ; Hastings, 64 ; York, 60 ; Dublin, 50 ; Ricketts, 41.

These figures taken in conjunction with the *recorded* number of deaths (which, of course, represents only a small proportion of the actual number) shows that malaria is still a factor to be reckoned with in the economic and social development of West Africa.

Yellow Fever.

In 1910, 13 diagnosed cases of this disease occurred in Freetown; these were not confined to one locality but were distributed over the town, some in the European part, some in the quarter where the Syrians congregate, and some in the purely native quarter. Ten deaths were recorded; these were as follows :—Europeans 5, Syrians 3, natives 2. In addition to these there were 11 suspicious cases, with one death. As has already been pointed out, *Stegomyia fasciata* is ubiquitous in Freetown, but stringent measures are being adopted for its diminution. A special Commission is also studying this disease in Freetown, as well as in all the other large coast towns.

Sleeping Sickness.

Only one diagnosed case of this disease has been recorded from the Protectorate, for though several other suspicious cases have been examined, no trypanosomes were found. During my tour in the Protectorate I came across two natives, a man and a woman, at Kamatoto, in the Kaballa district, both showing symptoms which seemed to indicate trypanosomiasis. Blood films were taken from each, but no trypanosomes could be detected.

The Principal Medical Officer in his annual report for 1910 says : "From the reports of Medical Officers I am inclined to think that human trypanosomiasis is at least not on the increase in Sierra Leone."

Trypanosomiasis of Stock.

This disease has been referred to in several parts of the report, but more especially on p. 164 with regard to Kamatoto and Yiraia Sokurella. There can be no doubt that this disease is very prevalent, but so far as one can gather it does not seem to account for anything like a heavy mortality, if we exclude the two exceptional cases mentioned.

In the Koinadugu district, cattle form a large source of the wealth of the natives, especially the Limbas, and an examination of the map shows that *Glossina palpalis* and *G. longipalpis* are very abundantly distributed in this region. The Timanis are great cattle breeders and reference has already been made to the large cattle towns, *e.g.*, Rowerri and Resorse, in the Karene District. In fact, it may be said that, with few exceptions, cattle are to be found all over the Protectorate. In most places they look exceedingly healthy (Plate XVIII, fig. 1).

It is very difficult to say how far immunity may have been acquired, but one thing is certain, namely that, despite all the conditions for infection being present, the rate of mortality is low.

On the other hand, Sierra Leone has a bad reputation for horses. Of seven examined between Port Lokko and Kaballa, near the Great Skarsies River, trypanosomes were found in the blood of three. The infection was very scanty and it is very difficult to say what the species was, but morphologically they appeared to belong to *Trypanosoma evansi.*

Some years ago, several donkeys were brought from the Gambia to Sierra Leone and quartered at Port Lokko—perhaps the most unfortunate selection of a camp that could have been made. In a short time nearly all died, but, so far as I could find out, no data or history of the cases is available for any definite conclusions to be drawn as to the cause of death. When I was at Port Lokko in 1912, I saw a foal belonging to one of these donkeys, and it looked in perfect condition and showed no signs of trypanosomiasis. This experiment is well worth repeating because, so far as one can see, the conditions are quite as favourable for donkeys in Sierra Leone as in the Gambia. The original experiment should be disregarded, as it proves absolutely nothing. If such an experiment be undertaken, it must be done under proper supervision and a detailed history, both clinical and microscopic, of every case should be kept.

The two epidemics referred to on p. 164 call for attention at this point. The history of these as given by the natives is certainly suggestive of trypanosomiasis, and one is immediately confronted by the question of the source of infection. I have nothing further to add to what has already been said, but I would once more point out the desirability of a systematic examination of the blood of all game, large and small. The solution of this problem and the introduction of animal transport to Sierra Leone would mean a material increase in the prosperity of the Colony.

VII. The Genus Glossina.

This genus is represented in Sierra Leone by five species, namely :—*G. palpalis*, *G. fusca*, *G. longipalpis*, *G. pallicera*, and *G. nigrofusca.*

Of these, however, only the first three require to be taken into account in a discussion on distribution, as our knowledge of *G. pallicera* and *G. nigrofusca* is based on a single record in each case.

In my report on Southern Nigeria, I dealt at considerable length with the factors influencing the distribution of *G. palpalis*, *G. tachinoides*, *G. submorsitans*, *G. longipalpis*, and *G. fusca* in Nigeria, and the conclusions arrived at for that region are equally applicable to Sierra Leone. Briefly stated, it may be said that Southern Nigeria and Sierra Leone are almost identical in the conditions which tend to support the existence of the three species of *Glossina* to be discussed here.

In the report mentioned the following occurs: "This species (*Glossina palpalis*) is ubiquitous along the coast region and follows the course of all the rivers. It exists wherever the rainfall is great, where the dry season is not of long duration, where the vegetation is dense, and always along the basins of rivers. Where any or all of these factors are less accentuated, the number of individuals tends to decrease."

Reference to the chapters on Geography and Climate in this report will show that these conditions are fulfilled throughout the whole of Sierra Leone, and a glance at the map will be sufficient to indicate that this species is ubiquitous but follows more closely the river courses.

In the same report a comparison was made between the conditions most favourable to *G. submorsitans* and *G. longipalpis*, and it was pointed out that *G. submorsitans* inhabited the drier regions where savannah forest was predominant, while *G. longipalpis* was associated with a moister climate and a slightly denser type of vegetation. In no part of Sierra Leone are the conditions favourable for *G. submorsitans*, but in the Koinadugu district conditions similar to those in which *G. longipalpis* occurs in Southern Nigeria are to be found, and there, as the map will show, do we find this species widely distributed.

Glossina fusca favours dense vegetation and a moderately moist climate, and is to be found in Sierra Leone in the regions of densest forest growth; in fact, as the map will indicate, the delimitation of the forests (*see* page 155) is at the same time a delimitation of the areas where *Glossina fusca* occurs.

VIII. The Genus Stegomyia.

This genus being instrumental in the transmission of yellow fever, which is all too prevalent in West Africa, calls for some consideration. I have already referred* to two papers on this subject, the first by the late Sir Rubert Boyce, and the second by Dr. W. M. Graham, and I have also detailed the distribution of the various species of this genus in Southern Nigeria and elsewhere in West Africa.

In Sierra Leone three species are met with, namely, *S. fasciata*, *S. sugens* and *S. apicoargentea*. Reference has been made in different parts of this report to the breeding places of this genus, so that it is unnecessary to reiterate them here, and I shall content myself for the present with recording the localities in which each species has been found.

S. fasciata:—Freetown; Cline Town; Batkanu; Moyamba; Daru; Makump; Gberea; Tungea; Kondundu; near Kondita, at the River Lolo; Benikoro; Firiwa; Sandea; Jowati and Bonthe. In several places this species was found in the bush far from human habitations.

* Bull. Ent. Res., iii, p. 191.

S. sugens :—Freetown; Kaballa; Batkanu; Benikoro; Firiwa; Sonkonia; Tirikoro. In one case the larvae of this species were found in a pool in the river Waliki, over 5 miles from a human habitation, and again in a pool in an exposed rock near the source of the Niger, at least two miles from the nearest village.

S. apicoargentea :—Daru.

From these data it will be seen that this genus, and especially the species *fasciata*, is not restricted to any definite region but occurs at very widely separated localities in the Colony and Protectorate. In Freetown more than 90 per cent. of the samples of mosquito larvae found in the native compounds and elsewhere proved to be *S. fasciata*.

IX. Parasites of Mammals, Birds and Reptiles.

Scattered throughout the report will be found records of the various ecto- and endo-parasites from mammals, birds and reptiles, examined in Sierra Leone. It might be useful, however, to collect and bring together all such records in a form more handy for reference.

The author hopes at some future time to make a more exhaustive study of the various parasites in West Africa, their hosts and distribution, but in the meantime little more can be done than to tabulate those found in the different colonies. During my tour in Sierra Leone, I made a large collection of Mallophaga and Anoplura from mammals and birds; several of the birds were obtained by the author, but the great majority were shot by Major H. J. Kelsall, R.A., who accompanied me on a bird-collecting tour for two months. These parasites have not yet been identified and cannot be included in this list. Many worms taken from different hosts also await identification, so that the following list can be regarded only as provisional.

Mammals.

Cattle :—*Boophilus australis, Haemaphysalis leachi, Amblyomma variegatum.*

Dogs :—*Rhipicephalus sanguineus, R. simus, Haemaphysalis leachi, Ctenocephalus canis, Ct. felis.*

Elephant :—*Amblyomma tholloni, Dermacentor circumguttatus.*

Water-buck :—*Amblyomma* sp.

Bush-buck or Harnessed Antelope :—*Haemaphysalis parmata.*

Marsh Mongoose (*Mongos paludinosus*) :—*Haemaphysalis leachi* (see page 176), *Ixodes* sp. n., *Porocephalus* sp. (in lungs).

Birds.

Bush-Shrike (*Dryoscopus turetii*) :—*Haemaphysalis leachi.*

Bush-fowl or Francolin (*Francolinus bicalcaratus*) :—*Haemaphysalis leachi.*

Reptiles.

Black Cobra (*Naia albicollis*) :—*Porocephalus* sp.

Lizard (*Agama colonorum*) :—*Geckobia* ?*neumanni.*

In conclusion, I wish to take this opportunity of thanking His Excellency the Governor, Sir E. Mereweather, K.C.M.G., and all those officials with whom my

work brought me in contact. Especially should I like to express my indebtedness to Mr. E. E. Evelyn, I.S.O., through whom all arrangements were carried out in a most expeditious manner; to Dr. R. M. Forde, the Principal Medical Officer, and Dr. R. H. Kennan, the Senior Sanitary Officer, for their kind co-operation; to Dr. D. Alexander, now Senior Sanitary Officer of the Gold Coast, and Col. Newstead, the Officer Commanding the West African Frontier Force at Daru, for much kind hospitality and assistance; to all those who have sent collections and whose records are included in this report; and also to the various officials, medical and political, in whose districts I travelled, for their kind hospitality, their whole-hearted support, and the many ways in which they helped to further the investigation.

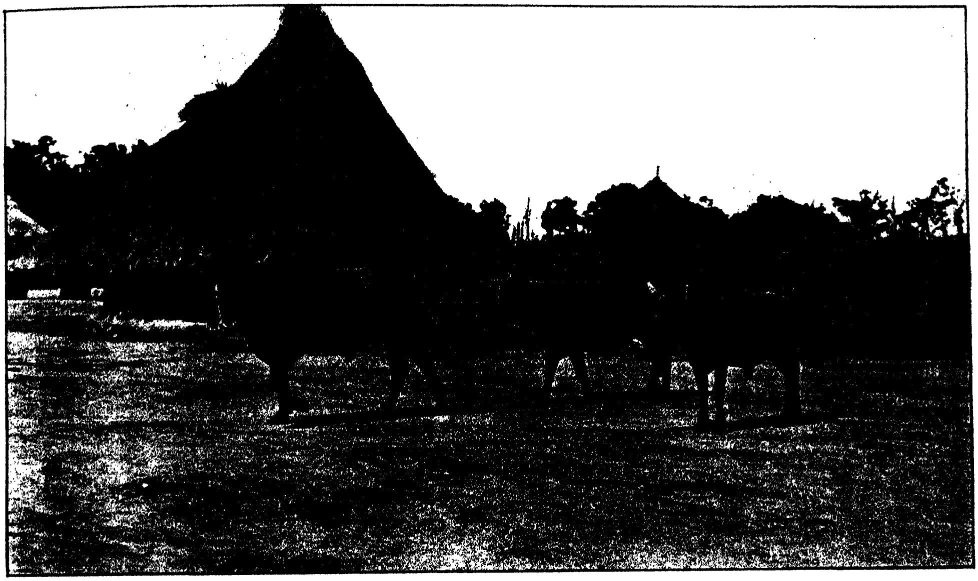


Fig. 1. Sierra Leone Cattle.

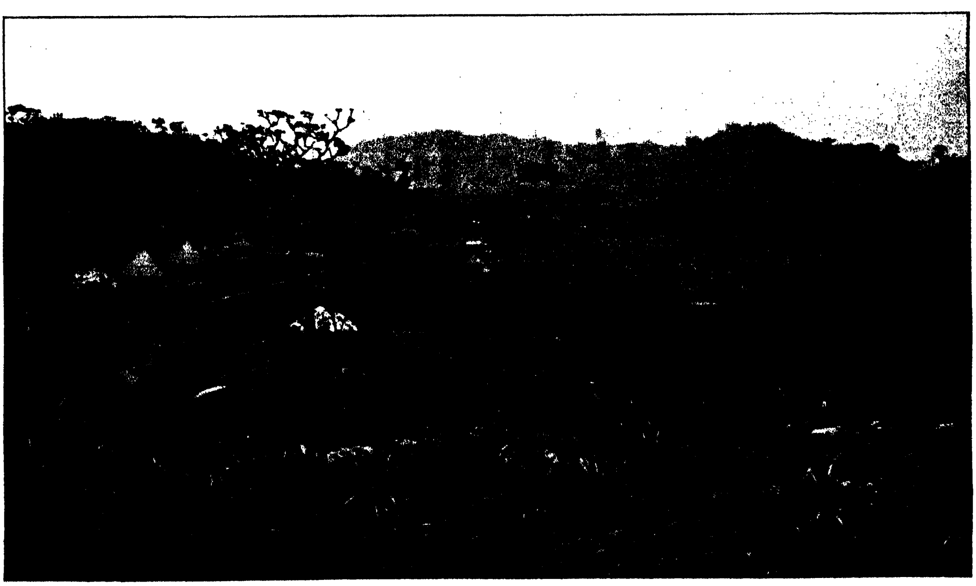


Fig. 2. View of the native lines, Kaballa.

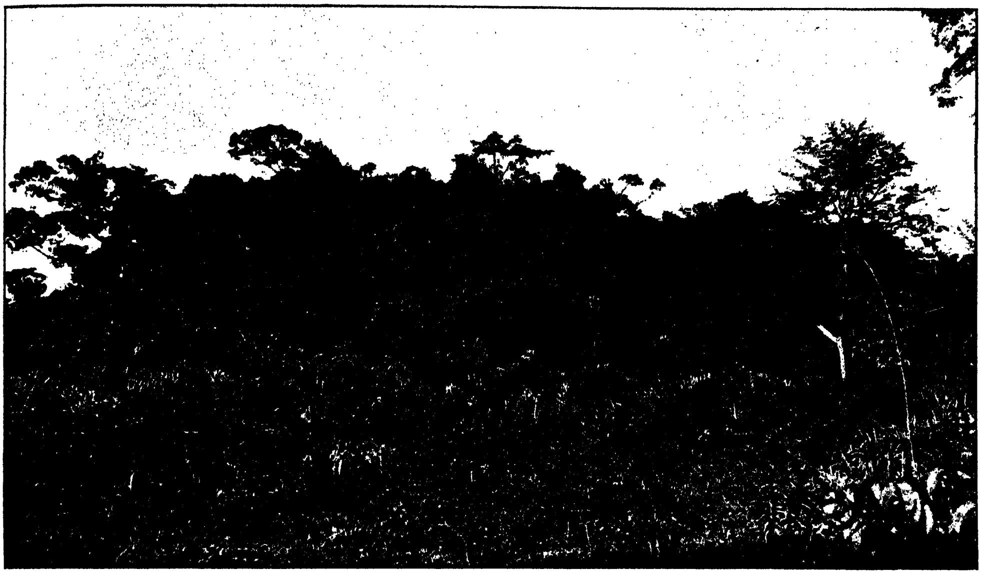


Fig. 1. View to show the nature of the bush around Bo.

Fig. 2. View on the Moa River at Bandasuma.

Fig. 1. View on the Bum Kittam River showing the low-lying swampy nature of the banks.

Fig. 2. Another view on the Bum Kittam River.

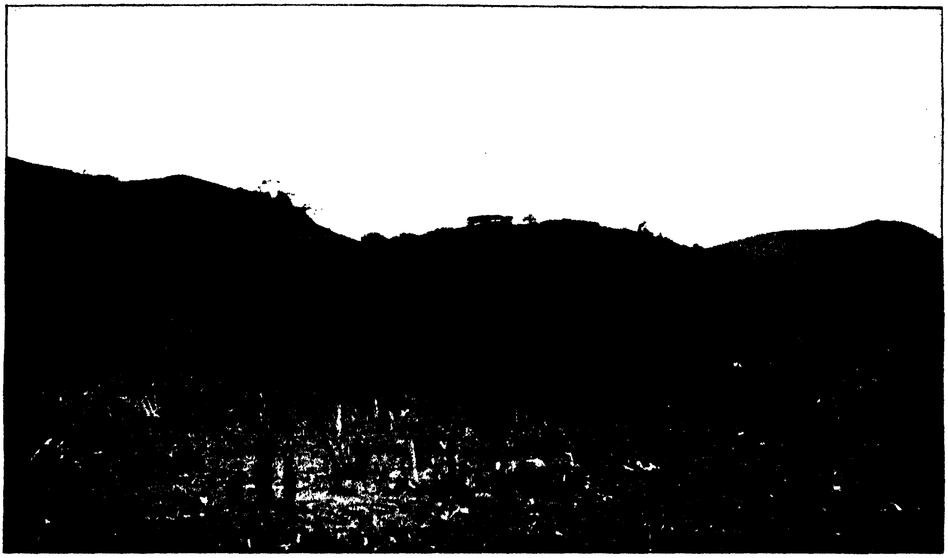


Fig. 1. View at Gbangbama showing the nature of the country and the position of the Commissioner's bungalow.

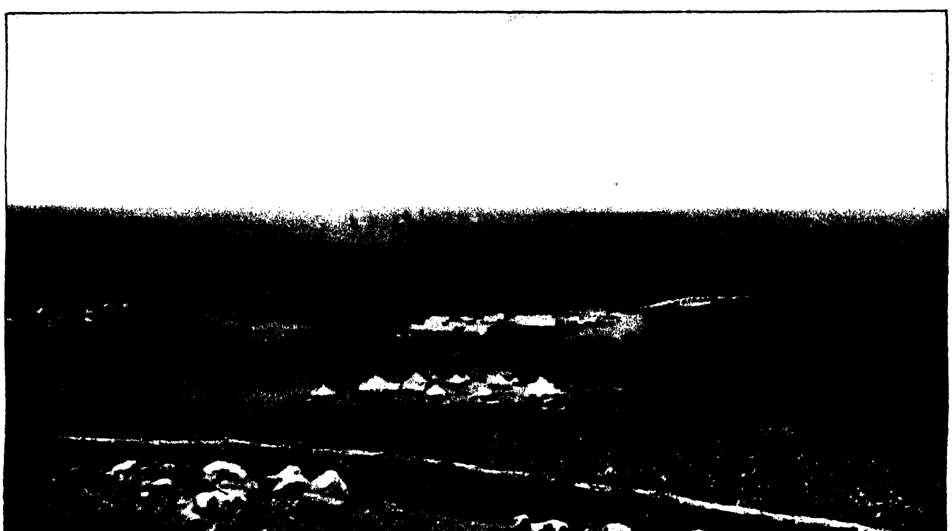


Fig. 2. View at Gbangbama, taken from the Commissioner's bungalow, showing the soldiers' lines and jail.

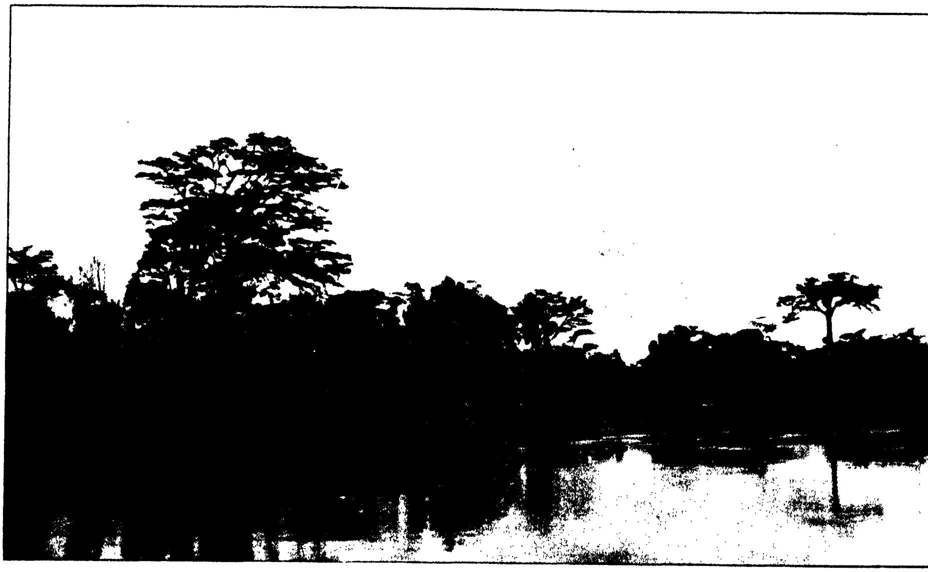


Fig. 1. View on the Bum or Sewa River, showing the nature of the vegetation near Mafwe.

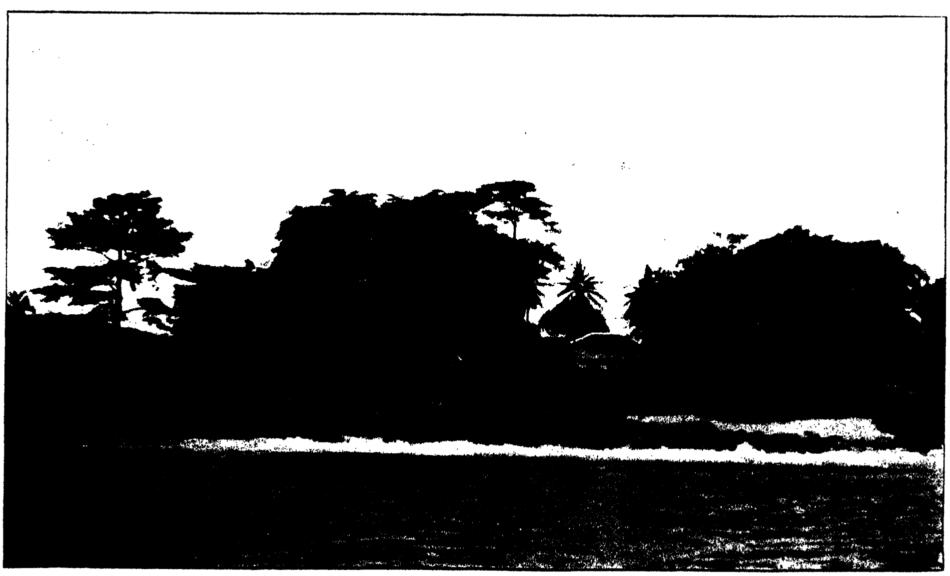


Fig. 2. View at Dublin, on the Banana Islands.

ENTOMOLOGICAL PESTS AND PROBLEMS OF SOUTHERN NIGERIA.

By A. D. Peacock, B.Sc.

Late Entomologist to the Agricultural Department, Southern Nigeria.

(Plates XXIII—XXVIII.)

The account of the entomological work carried out by the writer in Southern Nigeria falls naturally into three sections, October–December 1911, January–June 1912, and June–October 1912. During the first period, work, principally on cotton pests, was carried on at the Agricultural Headquarters, Ibadan, particular attention being devoted to the Red Cotton Stainer Bug. The second period was given to travel (fig. 1), when the entomological problems of the different districts were studied on the spot, and lectures were given *en route* to meetings of native chiefs, native agricultural societies, schools and school teachers. The third period was spent in dealing with the insects of nursery cocoa, cotton, maize and yam. Lectures and demonstrations were given to agricultural pupils. A small amount of work with insecticides was attempted. In conjunction with the Mycologist, rules were formulated for conducting the three first Fumigatoria of the Colony.

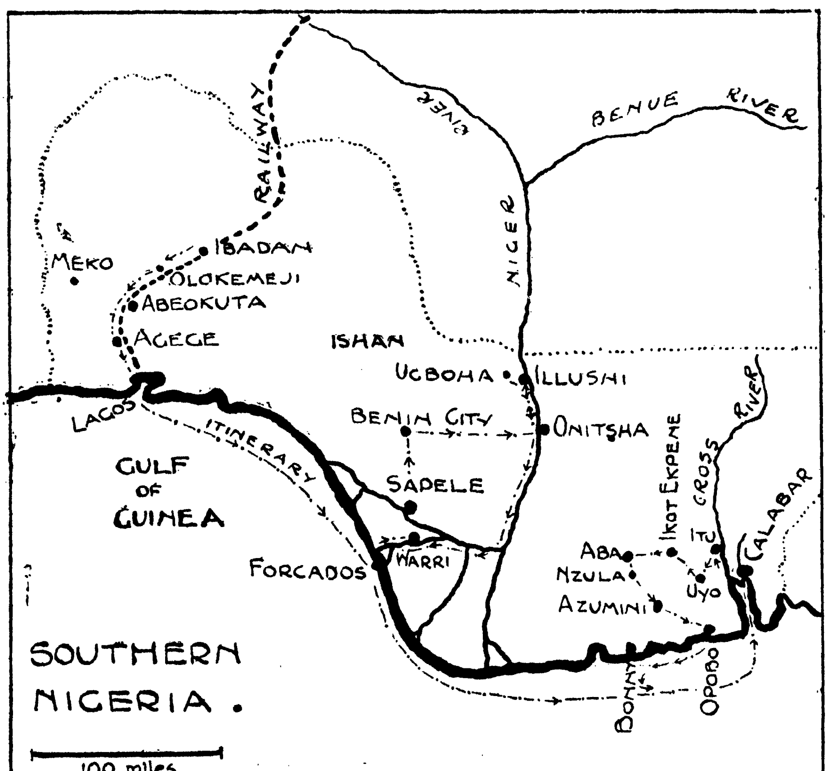


Fig. 1.—Sketch-map of Southern Nigeria, showing the author's itinerary.

INSECTS AFFECTING COTTON.

Most of the research on the insects of cotton was prosecuted at the headquarters of the Agricultural Department, Ibadan, during the latter part of the 1911 cotton season and the early part of the 1912 season ; during 1911 attention was principally directed to the Red Cotton Stainer. In that year, the Department had about 90 acres of cotton under experiment, mostly in 10-acre blocks, and, in 1912, about 50 acres in 5-acre blocks. Nyasaland, Meko and Ishan cottons were cultivated, but the bulk was American of the varieties Georgia, Truitt's Big Boll, Mebane and Upland. Agege cotton was grown from seed which the native farmers at Agege had mixed, the mixture being of native and American seeds.

The entomological work was done in conjunction with the efforts of the Agricultural Department to find the most suitable variety of cotton for Southern Nigeria. Consequently the Nigerian pests on American cotton were principally studied. Reference to work on native cottons is frequently made. The accounts of many of the insects must be regarded as preliminary, particularly those parts dealing with Parasitic Hymenoptera, APHIDAE and COCCIDAE.

HARMFUL INSECTS.

Cotton Stainers.

Dysdercus superstitiosus, F. (Plate XXIII).

The Red Cotton Stainer Bug has been observed at Ibadan and Agege in the Western Province, at Benin City and Ugboha in the Central Province, and at Calabar in the Eastern Province. From these observations and the amount of stained cotton brought into the markets from the surrounding outlying districts it may be concluded that the bug is widely distributed throughout the Colony.

The adults and young have very similar habits. They are mostly in evidence during March, the time of ripening and shedding of the seed of the silk-cotton tree, and from September to the end of November during the ripening of the cotton bolls. They creep over the ground, sheltering under the low bush plants and weeds which have survived the clearing of the cotton field, and climb actively over the leaves, flowers and bolls of the cotton plants. They show a distinct preference for shade during the heat of the day. As the cotton season advances they simply swarm (Plate XXIII, fig. 10).

These insects suck the juices of the rich oily seeds of the cotton and silk-cotton tree, and stain the white lint or down of their food-plant with yellow excretory juices. At Ugboha, during April 1912, a somewhat striking observation was made ; a number of young stainers, about three weeks old, were found sucking a dead snail. Instances of carnivorous habits among the Pyrrhocoridae are not at all common.

When the larvæ are feeding the head quivers, there is a long heave up at times which causes the stylets to lengthen and the bent part of the labium to straighten (Plate XXIII, figs. 11, 12). The labium may be tucked away beneath the body while the stylets still work in and out of the seed, bending and shivering like fretsaw blades.

The only observed breeding season commenced in August and lasted till December, coinciding with the cotton season. The earliest date recorded for finding couples in copulation was 28th August 1911, on ripening Hibiscus plants in the Nursery at Ibadan. In March and April 1912, however, young forms from one week upward in age were observed at Benin City, but the adults of this generation

were not found. This period coincides with the time of ripening and shedding of the seed of the silk-cotton tree.

The questions as to the number of broods in the year and the special local plants upon which the insects feed, have not yet been settled.

The eggs are of a cream-colour, translucent, about 1 mm. in length and shaped somewhat like a fowl's egg (Plate XXIII, figs. 1, 2). They are laid in clusters and the number in each cluster varies a great deal. The clusters deposited by captive specimens were found to have eggs to the number of 20, 36, 36, 45, 50, 57, 70, 74, 77, 81, 83, 98 and 120 respectively, giving an average of 63. It is probable that the average is really higher, as the conditions of the laboratory experiments were not so natural as could be desired.

Only once, after repeated searching, were the eggs found in a dry dead boll. This suggested that they were laid on the ground, but the exact situation was not readily found. Large numbers of very young stainers, only a few days hatched, were observed under the shelter of weeds in the hollows between the rows of cotton plants, and numbers of stainers in copulation were also noticed there. After much and frequent searching the eggs were at last discovered. They were deposited singly or, more usually, in clusters among the loose soil under weeds and preferably in quite sheltered spots. In the laboratory the egg-stage in various cases lasted for 3, 5, 6 and 7 days.

Two experiments were tried to find the percentage of young hatched, but the results cannot be considered conclusive. In one instance the result was 25 per cent. and in the other 42 per cent. It is probable that the normal period of incubation is about 4–5 days and that a far greater percentage hatches, as the conditions of the experiments were not at all natural.

The newly hatched young soon become active and, crawling up the cotton stalk, swarm upon the opened bolls and suck the cotton seed. There are five moults and after each moult changes in proportion, structure and colour are observable (Plate XXIII, figs. 3–7).

Foodstuffs are plentiful. The chief known are cotton, Hibiscus plants and the silk-cotton tree, while other malvaceous bush plants are certainly frequented. In the case of cotton, especially if the native planter, as he usually does, leaves unpicked bolls on his plants, the stainers have food from September till after December. In the case of the silk cotton tree, which is widely distributed and scatters its seeds wide-spread, food is provided from March till April. Malvaceous plants ripen in the bush at all times. It has also been mentioned that the young may be carnivorous.

There may be natural enemies, but after much observation they have not been discovered.

Even should the following figures be modified in the future, they may serve to give some idea as to the rate of development of the insect.

Number of days from copulation to egg-laying	7
,, ,, in the egg stage	5
,, ,, to 3rd moult, at least	28–32
	40–44
,, ,, to 5th moult, say	28
Total ..	68–72

Hence it is probable that a new generation may be full-grown in about nine to ten weeks.

The stainer is the worst pest of Southern Nigerian cotton, and does an immense amount of harm both to the seed and to the lint. The stained condition of the cotton in the native markets in the Western Province, and especially the cotton gathered late in the season, is striking. At Illushi, on the Niger, where the native Ishan cotton is ginned, the lint seems much cleaner. It is regrettable that no figures are available to show the exact proportion of stained to unstained in imported and indigenous cottons. From observations on imported cotton at the Agricultural Station, Ibadan, it may be put, very tentatively, at 20 per cent. Native cotton is not so badly stained.

It has yet to be demonstrated for Southern Nigeria that it would pay the native (and the European buyers and manufacturers) to take increased care in the production of cleaner cotton.

The problems of treatment are:—

(1) What preventive measures can be adopted to prevent the stainers from breeding among the cotton?

(2) What measures can be taken, once the stainers are present?

(3) What is the practical value of such measures?

A statement of experiments may be given first. The period and opportunities of the tour were rather unfortunate for the carrying out of work on a large scale and at the best time, which is from the end of October onwards.

Experiments. (1) An experiment was performed at the end of November 1911, among the "Georgia" cotton, to test the value of cotton seed and pressed seed as baits. Small handfuls of bait were placed at intervals of about six feet between the drills. After a few days a few young stainers were found swarming about one heap of bait. Evidently some adult had laid eggs among it. The results of a longer period were not satisfactory.

(2) A quantitative experiment was made on 14th December 1911, among late ripening Nyasaland Upland Cotton. The objects were:—(*a*) to find the effect of bait; (*b*) to find the approximate amount of labour and material required to carry out the experiment. The land had been well cleared and the furrows were two feet wide. A large number of patches of weed had sprung up, however, and were acting as breeding and sheltering places for the stainers. The bait was laid in quantities—about as much as could be taken up by two fingers and the thumb—on large cotton leaves at intervals of about six feet. The rows were laid with cotton seed and pressed cotton seed alternately. The bait served the purpose of enticing stainers, but the collecting of them could not be carried out owing to the writer leaving the plantation on tour.

From the results obtained the following estimate was arrived at:—To clear and lay traps on 10 acres of cotton would occupy 25 labourers and one head-man for one day of 8½ hours. This would cost £1 for labour, and the cost of collecting the stainers would be about 10*s*. The process would have to be performed twice, giving a total estimated cost of £3 for the 10 acres.

Preventive Measures. The imported American and Nyasaland cotton plants are smaller than the indigenous Meko or Ishan plants and more easily dealt with. Constant field work has fully demonstrated the great importance of keeping the

plantations clean. Unless stumping is thoroughly carried out and weeding is particularly looked to, the plots become so unclean from vigorous weeds that there is every encouragement given to the stainers to shelter from the sun and breed in comfort. The presence of the silk-cotton tree has also been shown to be an additional cause of the flourishing of the pest. If successful cotton plantations are to be made silk-cotton trees will have to go.

Collecting. This will be best undertaken early in the cotton season when the sexes are coupling. From experience at Ibadan the best time is about the beginning of November, but this will vary according to seasonal conditions or geographical position.

With regard to the method of collecting, experience points to net-collecting as being the most practicable, and the apparatus shown in the accompanying diagram

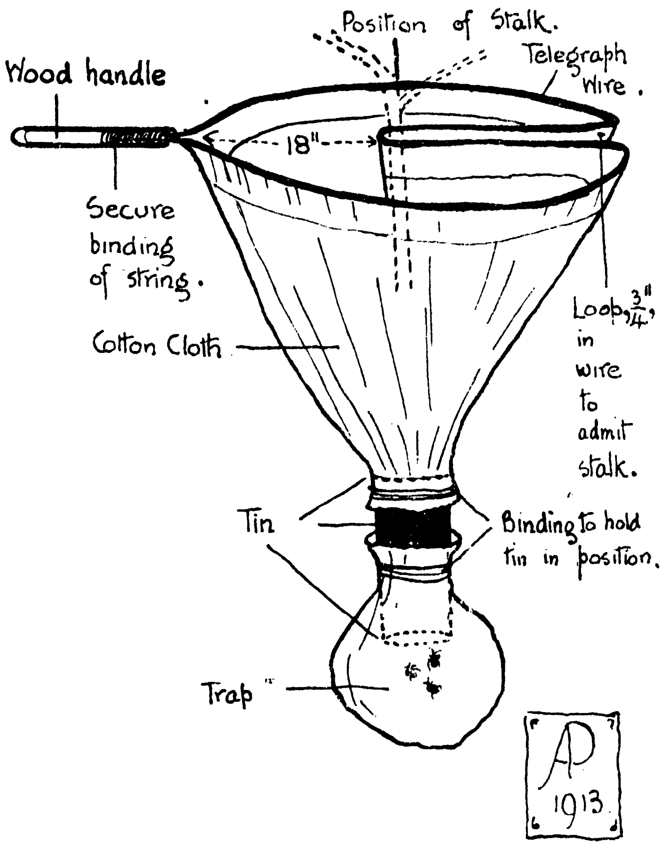


Fig. 2.—Type of collecting net suggested for use against Red Cotton Stainers.

(fig. 2) is suggested as being very convenient for the purpose. The credit for the idea of a trap at the bottom of the net belongs to Mr. Ballou whose pamphlet on the West Indian Red Cotton Bug gives a diagram of a collecting net. The net is thrust under the plant, as indicated, and the stainers are shaken into it, and when collecting is finished, they are killed by throwing into water and

kerosene. Another alternative is for each collector to carry a net without a trap and to take with him a tin of water and kerosene, into which the insects can immediately be thrown.

Trap Crops. It remains to be shown experimentally whether it would be of practical utility to plant a crop of some species of Hibiscus or cotton which would ripen earlier than the main crop and thus serve as a trap. If the stainers could be successfully attracted to the trap crop, the numbers collected and killed might have some appreciable effect in lessening the number on the cotton.

It is suggested that the trap crop be planted two deep round the plot and at sparse intervals between the rows of cotton plants. It should be destroyed immediately it has served its purpose, otherwise it might merely become an additional breeding-ground for the pest.

When and how often collecting should be done and the more general application of methods to the needs of the Colony remain to be ascertained by future work.

General Measures. The following are sound practical working measures adopted by Mr. Henderson, Superintendent of Agriculture, Ibadan:—

(1) Gathering the cotton immediately it is ripe.

(2) Sunning it well and constantly turning it over, which causes the stainers to crawl away, when they can be collected and killed ; the chances of further staining in the ginning are also reduced.

(3) Burning the old cotton stalks, which, if left, only harbour the pests.

These suggestions will only be of practical value if they are carried out wholesale and in a spirit of co-operation. Any campaign against the red cotton stainer must not be in isolated skirmishes, but in persistent whole-line attacks. It is a big problem for a new colony.

These methods are impracticable for native cottons because of the height (6 feet and over), woodiness and spread of the plants. But on the other hand, the Ishan cotton examined at Illushi, Central Province, was much cleaner than imported varieties. So one is driven to choose between foreign cottons carefully guarded from stainers and an improved native type. The latter, carefully selected for wieldy size and increased lint-bearing qualities, will probably prove the more satisfactory. Needless to say, a resistant indigenous cotton grown from selected seed would be of greater value to the native grower, for he will not trouble to combat the insect pests, but tolerates their presence in a fatalistic spirit.

Oxycarenus dudgeoni, Dist. (Plate XXV, fig. 3).

The Black Cotton Stainer has been found at Ibadan, Western Province, and Ugboha, Eastern Province ; it is therefore probably distributed throughout all the Colony.

The time of appearance during the cotton seasons 1911 and 1912 was found to be slightly later than that of the Red Cotton Stainer. The earliest date of finding them on cotton was 1st November.

They feed and breed in the opened cotton bolls, sucking the juices from the seeds. The sexes have been found paired from November at Ibadan, and in April at Ugboha.

The eggs are cream-coloured, about 0·6 mm. in length, and are laid in clusters at the base of the boll, securely protected by the lint from sun and possible enemies. The number laid by each female is not known for certain, but seems small, about 20. At the beginning of December the small, reddish brown, wingless young have been found swarming and active in the bolls.

There seems a decided preference for certain species of Hibiscus as food-plants, for in the Nursery at Ibadan the ripening plants were found to be black with these pests. The insects seemed to be feeding on all parts of the plant, which is not the case with cotton. Their bush food-plants are not known.

The security of the place of development greatly assists their multiplication. The rate of increase is rapid, but whether owing to the number of eggs laid by each individual, or to the number of generations per season, is uncertain.

At Ugboha these insects occurred in amazing quantities. Several acres of neglected cotton plants, with unpicked and late-ripening bolls, were literally alive with the bugs, and gave some idea of what unchecked feeding and breeding could produce.

It is not safe at present to state the extent of the harm done by these insects; but their abundance indicates that very real damage is being done to the seeds at least. Whether they stain the lint seriously cannot be said.

The measures suggested to combat the Red Cotton Bug apply equally well here. The sunning of the collected lint has been found to be especially efficacious.

Boll-Worms.

Three kinds of boll-worms have been studied from the cotton plots of the Agricultural Department at Ibadan, namely, *Diparopsis castanea*, Hmp., *Earias biplaga*, Wlk., and *Chloridea obsoleta*, F. Observations at Agege, and information received at Ugboha (Eastern Province) point to their being widely distributed throughout the Colony.

The caterpillars bore into the unopened ripening cotton bolls and devour the seeds inside, while *Diparopsis castanea* and *Chloridea obsoleta* are known to eat the cotton flower-buds also. The larvae leave one boll for others and frequently all the bolls on one tree are utterly spoilt.

The moths are all nocturnal, but while the adult of *Diparopsis castanea* has been captured at night, the other two have only been reared in the laboratory. The earliest date of their appearance was found to be September.

The only details of the life-history mentioned here are those noted in the Colony. *Diparopsis castanea* is discussed in the "Third Report of the Wellcome Research Laboratories, Khartoum," and *Chloridea obsoleta* in "Bulletin 50 of the Department of Agriculture, U.S.A."

Diparopsis castanea, Hmp. (Plate XXIV, fig. 2).

Some of the following information is derived from the notes of Mr. C. W. Jemmett, Entomologist in Southern Nigeria from 1909–11.

The eggs are very small and blue and are laid on the leaves in September. The larva is pale green, with red blotchy markings, and grows to about one inch. When full-grown it burrows a few inches into the soil and makes an earthern cocoon. The pupa is pale yellow, and the pupal period occupies from 12 to 19 days.

Earias biplaga, Walk. (Plate XXIV, fig. 5).

The eggs are unknown. The larva is 'spiked' in appearance and pleasingly coloured, being blotched with green and yellow with touches of red. It grows to about $\frac{3}{4}$ inch in length and then spins a cocoon of white silk about $\frac{7}{8}$ inch in length, and shaped like an overturned boat. These may be found on bracts of the bolls and even on weeds in the cotton field. The pupal stage lasts from 11 to 15 days.

Chloridea obsoleta, F. (Plate XXIV, fig. 10).

The eggs have not been observed. The larvae noted were of a green colour and reached a length of about $1\frac{1}{2}$ inches, being much larger than those of either of the other two species. The pupal period occupies 14 days, the larva pupating in the soil.

The indigenous food-plants of these pests have not been ascertained, nor is there any information as to the number of generations in a year. But the serious condition of a great number of plants observed in 1911 must mean either a large first generation or the quick succession of more than one generation.

No natural enemies have been discovered so far in the Colony, but it is probable that there are such.

Diparopsis castanea and *Earias biplaga* were detected during the cotton season of 1911, the former being the principal boll pest. *Chloridea obsoleta* was not observed till the 1912 season, but the caterpillars were then very plentiful, though their relative importance as compared with *D. castanea* is not known.

Indigenous cotton also suffers from the attacks of these insects, but it is difficult to compare the damage with that done to the American varieties, for the size of the native plants makes investigation almost impracticable. But the condition of the plants towards the end of the 1911 season was found to be serious.

Treatment.

Imported Cottons.—Experience has shown that the time taken to examine, detect and hand-pick the affected bolls was very long; and dusting the bolls with dry poisons would also be too lengthy a process for practical purposes. Of course young children might be taught to do the work quickly and skilfully, but the advantages of spraying are greater, and this method is effective against the leaf-rolling caterpillars as well as the boll-worms.

The method of attack may be outlined as follows:—

(1) A careful look-out should be kept for leaf-rollers and boll-worms during August and September.

(2) Immediately the presence of the insects is detected, the leaves, bracts, bolls and buds in the affected area should be most thoroughly sprayed.

(3) The number of sprayings must depend upon the condition of the crops as the season advances.

(4) At the end of the season all the old stalks with the diseased bolls should be burnt.

Failing a power spraying machine, a number of machines which can be wheeled between the rows of plants should be used. The most recent work on insecticides goes to prove that lead chromate is a most easily handled and effective poison.

Native Cottons.—Before native cottons at Ibadan can be treated as suggested above, two courses are open :—(1) The obtaining, by selection, of a smaller native variety ; (2) the topping and trimming of the plants and widening the distance between the drills.

It remains to be shown by experiment whether the latter method, *plus* the assistance of entomological treatment, would be preferable to the present method.

Leaf-rolling Caterpillars.

Sylepta derogata, F. (Plate XXV, fig. 7), and *Zebronia phenice*, Cram. (Plate XXV, fig. 5).

Both insects are evidently wide-spread throughout the Colony, as specimens have been obtained from both the Western and Eastern Provinces. It was observed at Ibadan that *S. derogata* was particularly plentiful among cotton which was planted near a small stream and overshadowed by a large number of palm trees. The plants supported the caterpillars, while the moths lurked in great numbers among the thick grass and weeds fringing the stream. In an area of 600 square yards examined, every single cotton plant was attacked by the larvae, and in most cases all the leaves were riddled and rolled. *Z. phenice* is most usually found where okra (*Hibiscus esculentus*) is grown.

The larvae of both species cut and roll the leaves into the shape of a tent (Plate XXVII, fig. 1). In these shelters they feed on the inner rolls of the leaf.

Sylepta derogata is gregarious, and as many as 12 caterpillars may flourish in one shelter ; the earliest time of appearance for the larvae in Southern Nigeria was found to be 19th August 1911. *Zebronia phenice* was found first on the 7th November 1911, but must be active before that ; it was quite common during April in the Eastern Province. The larvae are usually solitary.

Sylepta derogata is dealt with by Lefroy in " Memoirs of Department of Agriculture in India, Vol. II., No. 6," and his account agrees with what has been observed in Southern Nigeria.

The eggs of *Zebronia phenice* have not been found. The larvae are green, slightly larger than those of *Sylepta derogata* and not so wet-looking. The pupae are brown and are found in a silken shelter spun in curls of the leaves. The pupal period lasts from 6 to 11 days.

The local food-plants are not known in the case of either species, nor are there any exact data as to the number of eggs and generations, but the short period of development indicates more than one generation and very rapid multiplication.

S. derogata is extensively parasitised by a species of BRACONIDAE, and a fly of the family TACHINIDAE also serves as a check (see under " Beneficial Insects ") ; but the proportion of parasitised to unparasitised caterpillars has not yet been ascertained. The only practical method of control is by spraying.

Green Fly.

The specimens collected were identified by Mr. F. V. Theobald as *Aphis gossypii*, Glov. The species is common at Ibadan, but nothing is known as to its occurrence in other districts, nor as to the indigenous food-plants, if any. The life-history has not yet been worked out.

The numbers of this *Aphis* are fortunately kept well in check by natural enemies. These include at least two species of ladybird, the larvae of three species of hover flies, and the larvae of two species of lacewing flies.

As an indication of the activity of the beneficial insects, two examples from the field may be taken. A small cotton plant with six leaves, badly affected by aphids, was being busily worked by 9 ladybird larvae and 3 hover fly larvae. To provide for the future a set of a dozen ladybird eggs were also present. A second similar plant had 3 ladybird larvae and 5 hover fly larvae. In the laboratory, the usual allowance per day for two adult lady-birds was a leaf with about 200 green fly upon it. The amount of useful work done by these checks is incalculable.

During the 1912 season the American cottons were most subject to attack by aphis. At Ibadan the pests were plentiful enough, but they were so well kept in check by enemies, that artificial methods of control were never warranted. This, however, does not mean that watchfulness should be abated. Should the aphis show the least sign of increasing beyond natural control, spraying must be done. For this a resin wash is recommended. (See Lefroy's "Insecticides.")

Leaf-eating Beetles.

The following beetles have also been observed to feed upon the leaves of cotton plants :—

COCCINELLIDAE : *Epilachna chrysomelina*, F., *E. similis*, Muls., var. *assimilis*, Muls. (larvae found also on grass).

LAGRIIDAE : *Lagria villosa*, F., and *L. viridipennis*, F. (both species were also found on yam and cowpea).

CURCULIONIDAE : *Siderodactylus* sp.

CHRYSOMELIDAE : *Syagrus calcaratus*, F. (Plate XXIV, fig. 6), *Plagiodera circumcincta*, Sahlb., *Ootheca mutabilis*, Sahlb. (Plate XXIV, fig. 8), *Nisotra uniforma*, Jac.

The two species of *Lagria* were found to be widely distributed in Southern Nigeria, but the remaining species were noted only at Ibadan, where they all occurred commonly.

While none of these beetles has been known to threaten the cotton crop seriously, it is important to regard each species as a potential pest. Further, the simultaneous activity of all the species may do quite as much harm as the excessive preponderance of one. Young cotton, particularly, should be carefully watched. Should the circumstances warrant, spraying with lead chromate is recommended.

Leaf-eating Caterpillars.

Euproctis sp.

Two specimens of this moth were found in the entomological collection upon the writer's arrival, but owing to their poor condition they could not be specifically determined.

The only facts recorded concerning the species were that the larvae had been found at Olokemeji, Western Province, on acclimatised American Upland cotton. These larvae were hairy, with red, black, yellow and white markings, and curious tufts.

Euproctis lyonia, Swinh.

The species was observed only at Ibadan. No eggs were found in the field, but a small swarm of 20 sluggish newly-hatched caterpillars was found on a leaf, the company probably representing the number of eggs in a single cluster. Curiously enough, in spite of search on the plant upon which the swarm occurred, no egg-membranes could be found. The larvae were typically Lymantriid, the dorsal tufts on the anterior segment of the abdomen being specially noticeable. The prevailing colour was ferruginous, though white and black were also present. The number of moults before pupation is at least three, and the larval life, judging from a single instance, must be a little more than 14 days. The cocoon of loose hairs and silk is about half an inch in length and light grey in colour, the pupal period being 13 to 14 days.

The larvae would appear to be extensively parasitised, for out of 14 young caterpillars reared in the laboratory only one moth was obtained, while 8 Braconid parasites, belonging to two species, emerged. As the caterpillars were collected shortly after hatching and carefully protected and reared in the laboratory, the interesting questions arise—When were the larvae parasitised, and is there any inter-relation between the parasites?

The caterpillars of the following moths occurred only casually upon cotton:—*Diacrisia maculosa*, Cram., *Diacrisia* sp., *Prodenia litura*, F., *Cosmophila erosa*, Hb., and *Alcis acaciaria*, Boisd.

Scale-Insects.

On two occasions at Ibadan, during the seasons 1911 and 1912, plants were observed covered with white, waxy, somewhat limpet-shaped scales which reached a length of half an inch. The specimens have been kindly identified by Prof. R. Newstead, F.R.S., who pronounces them to be *Pulvinaria jacksoni*, Newst. Specimens of a *Ripersia*, which cannot be identified, were also found on cotton.

Parasitic Hymenoptera.

Three species of the family CHALCIDIDAE and probably two of BRACONIDAE have been found harmful, for the reason that they are parasitic on beneficial insects. All but one, a Braconid, are parasitic on ladybird beetle larvae. The remaining Braconid is parasitic on the larvae of a hover fly (SYRPHIDAE).

It has not yet been possible to obtain identifications of these insects.

Note on the Condition of the Native Cotton Plants at the Agricultural Station, Ibadan.

The native Ishan and Meko cottons were found to be affected in a curious way. The leaves become at first mottled with light-coloured green, often yellow, spots, the undersides being densely and minutely pock-marked. Ultimately the leaves shrivel and curl. The young leaves at the shoot seem to be

affected first, the older and larger leaves afterwards, and the petioles and stalks become distorted till the whole plant presents a most forlorn appearance. The native variety among the Agege cotton was also similarly affected.

The disease was first observed in the Ishan Cotton, by the Assistant Superintendent of Agriculture about 20th July 1912, the cotton being then a month old and 9 inches high. No insect or mite was discovered, and the cause of the trouble is probably physical.

From the end of August to the end of October 1912 the trouble grew roughly from about 8 per cent. plants affected to about 25 per cent. The percentage was arrived at by observing, at different periods, the same plants to the number of 1,000 in the Ishan, and 1,800 in the Meko.

The plants were spoilt for bearing, but how seriously cannot be stated here, as further work was prevented owing to departure on leave. The matter was also investigated by the Government Mycologist, who has reported on the subject.

Beneficial Insects.

Ladybird Beetles.

The two species obtained have only been observed at Ibadan, but as they are quite common and widespread throughout Africa, it seems quite permissible to say that they may be found all over the Colony. The adults and larvae have very similar habits. The former appear early in August on the cotton plants, climbing actively, and specially frequenting the haunts of the Aphids, upon which they live.

Chilomenes lunata, F.

These beetles may be observed pairing on the plants early in August, and eggs were laid, in one instance, half an hour after pairing.

The latter are yellow in colour, about 1 mm. in length, spindle-shaped, with rounded ends. They stand on end and are found in clusters of six and more, usually placed on the cotton leaves among green fly. The numbers noted in various clusters were 6, 6, 7, 15, 18, and 21, an average of 12. In captivity the eggs have been devoured by either the male or female or both, but only when the usual food, green fly, has been absent. The eggs gradually turn a silvery grey in colour and usually all hatch in about four days.

The larvae are spiny and have a few large yellow spots. They are very active, and very soon after hatching crawl over the leaves seeking their food. The period of activity lasts 12–16 days. Three moults have been observed, at times when the insects were about $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ inch long. At the conclusion of this period of activity the larva fixes itself to the leaf by its tail and the body becomes rigid in a curved attitude. After a time the skin splits dorsally and reveals a yellow pupa.

The pupal period was found to be short, about 4–5 days; but in one exceptional case it lasted for 10 days. The soft yellow pupae are about the size of the adult ladybird. They are found, usually isolated, on the underside of the leaves of the cotton plants.

Whether the beetles feed solely on one species of green fly or on a number is not known, neither are the indigenous plants which they frequent when cotton is not growing.

The laboratory experiments show a heavy mortality among the larvae. The somewhat artificial conditions may account for this, though two other exceedingly interesting and important factors have been observed. These are cannibalism, probably induced by unnatural conditions, and parasitism. With regard to the latter point, it has already been mentioned that three species of Chalcids and one Braconid were bred from larvae of these beetles.

Keeping in view the shortness of the developmental period—about 20 to 25 days—and the length of the season when food is plentiful—August to November —it is not too much to estimate that three generations are possible.

Chilomenes vicina, Muls.

The numbers of eggs noted in single clusters were 3, 4, 7, 14 and 21, and they appear to hatch in about two days.

The larvae are smaller than those of *Chilomenes lunata*, being, when full grown, about half an inch long. They have many white spots upon a black spiny skin. The active period of the larvae is probably about 9 to 10 days, though from one case it would seem that 15 days may be taken. The pupal period takes four days.

There was a heavy mortality among the larvae in the laboratory, but there were no evidences of parasitism. They were not observed to feed on any insects except the cotton green fly, and the activities of these two *Chilomenes* have kept the *Aphis* well under control.

Hover Flies (Syrphidae).

Three species, *Paragus borbonicus*, Mcq., *Syrphus aegyptius*, Wied., and *S. nasutus*, Mcq., were found at Ibadan, all of which are widely distributed over Africa. The flies themselves have always been obtained in the field by netting as they hovered over the cotton plants. The larvae, which are quite common, crawl among the green fly on the cotton and suck them, thus materially assisting in their reduction.

Small solitary eggs, white and sculptured, have been found and seen to hatch among the green fly on the cotton leaves, but to which species the eggs belonged was not ascertained.

The larvae of *Paragus borbonicus* are of the typical shape, tapering to a point, about ½ inch long, and spiny. Their colour is light green, with a large brownish dorsal patch. The puparia are also spiny, and of a dirty light green colour. The pupal period lasts about 8 days.

It is very probable that the slim, smooth, soft green grubs, larger than the larvae of *Paragus borbonicus*, which were found upon cotton, are the larvae of *Syrphus nasutus*. The puparia are smooth and larger than those of the *Paragus*. The pupal period was, in two cases, 5 and 8 days respectively.

One species of the family BRACONIDAE is parasitic upon the larvae of *Paragus borbonicus*.

Lacewing Flies.

Two undetermined species of this group, *Hemerobius* sp. and *Chrysopa* sp., were bred from larvae which were found preying upon *Aphis gossypii*. The small brown *Hemerobius* is commoner than the larger green *Chrysopa*.

Parasitic Hymenoptera and Diptera.

Owing to the difficulty in identifying these insects and the great need for more systematic work on the African species, the parasites which were bred can merely be indicated.

One species of Braconid was bred from caterpillars of *Prodenia litura* and *Euproctis lyonia*; another from the latter species only; and a third from *Sylepta derogata*. A Tachinid fly, apparently referable to the genus *Sisyropa*, was bred from *Diacrisia maculosa*; and another from *Sylepta derogata*.

General Conclusions with regard to Cotton Pests.

From the details given above, the following conclusions stand out:—

1. Cotton demands unceasing watchfulness and care, right from the time when it has two leaves, when grasshopper, beetle and caterpillar attack may have effects detrimental to a good early start; through the leaf-growing period, when leaf-rollers, casual caterpillars and aphis are at work; through the all-important period of bud- and boll-formation, when boll-worms are active; and up to the ripening and picking period, when stainers are mischievous.

2. Dirty farming hinders easy working, robs the cultivated plants of nourishment and encourages pests. The burning of old plants at the end of the season assists greatly the destruction of stainers, boll-worms and leaf-rollers.

3. Experiments on the following lines would be useful:—

(*a*.) to obtain a native variety of cotton with less wood, smaller and more wieldy plants and a greater proportion of lint to seed cotton; (*b*.) to ascertain whether it is better, in dealing with native cottons, to widen the planting distances and drills so as to render the plants more accessible for the destruction of pests, or to retain the former planting methods, with practically no entomological treatment, and merely to top and trim the plants.

4. The measures recommended here are not difficult in themselves, but much patient, unhampered work is needed, and this takes time. Again, these will not be of the slightest use unless the principal pests are attacked with energy and co-operation by everyone, natives and officials alike.

The difficulties of making cotton worth extensive exploitation are many. These are, (1) the inertia of the native attitude toward cleanly farming; (2) the difficulty of obtaining a good variety of native cotton which would fetch better prices and so make it worth while expending labour and money in combating pests; (3) the difficulty of popularising even simple entomological methods; and (4), greatest of all, why should the native, as a man of business, grow cotton, when cocoa and rubber are much more valuable, and his country, besides, is the land, *par excellence*, of the oil palm?

Even if a better native variety is produced, cotton in Southern Nigeria will probably never be more than a useful native catch-crop.

INSECTS AFFECTING COCOA.

Most of the work done related to insects affecting young cocoa at the Government Model Farm, Agege, the Agricultural Station, Calabar, and at the Headquarters of the Agricultural Department, Ibadan. The cocoa at Agege was over

a year old and had been grown from seed planted at stake. It was densely shaded with pigeon pea. The cocoa at Ibadan varied in age from 2 to 7 months and grew under palm-leaf shades in baskets containing about 20 plants or in nursery beds. There were a few plants over a year old. The varieties included Red and Yellow Pod from the Agege district, Yellow Pod from the Gold Coast, and Amelonado.

There was very little opportunity for a study of the insects affecting bearing plants, but the cocoa farms of the Agege district were visited several times and the farms around Aba (Eastern Province) were visited while on tour.

HARMFUL INSECTS.

Leaf-eating caterpillars.

Diacrisia maculosa, Stoll (Plate XXV, fig. 4).

This moth was found to be very plentiful at Agege and Ibadan, and it is widely distributed throughout Africa. The caterpillars are voracious feeders, being found on cocoa, kola, cotton and maize. They were found on maize at Ibadan in October 1911; they were very common, late in June 1912 and onwards, on maize and cocoa growing near each other at Agege; early in July, at Ibadan, they were abundant on cocoa and maize, and from August onwards, on young cotton. They are very active in habit, crawling quite long distances in search of food, and have been frequently observed crossing from cocoa beds to maize.

The moths may be found in the early morning resting motionless on different parts of the plants and may then be easily caught.

The contrast between the appearance of the caterpillar before and after moulting is very striking. Before moulting the caterpillar loses its dark hair and the body appears banded alternately with vivid yellow and dark brown. After moulting the long dark hairs conceal the strong coloration.

The cocoons are about an inch in length and are made of the dark hairs of the caterpillar meshed together with silk. They have not been found in the field. The pupal period is from 13–18 days.

A Tachinid fly (*Sisyropa*) is known to be a natural check.

Prodenia litura, F. (Plate XXIV, fig. 9).

The caterpillars have been found quite commonly at Agege and Ibadan, and especially so among nursery cocoa at Calabar. The insect is widely distributed throughout the Tropics, and is likely to be found all over Southern Nigeria. The larvae prefer the leaves of cocoa to those of cotton and okra, but will flourish on any of them. They are common from May to November, but no special broods were noticed.

Metopius discolor, Tosq., an Ichneumonid, has been bred from a larva of this species.

Diacrisia sp.

This moth was only met with at Ibadan, where the caterpillar is quite common. It is densely covered with brush-like tufts of mouse-grey hair, and attains about 1 inch in length. It is very active and, like that of *D. maculosa*, may be seen travelling across open ground. It feeds on cocoa and cotton leaves.

The pupal period was found to vary somewhat, the times noted being 11, 14, 16, 18 and 23 days. Specimens reared from cocoa took longest to emerge. The life-cycle takes more than five weeks.

A superficial description of the moth is as follows:—The wing-expanse is about 1½ in.; the wings are white; the forewings have a few black specks and a characteristic thin line of orange along the anterior border.

Rhopalocampta forestan, Cram. (Plate XXIV, fig. 3).

The larvae have only been observed at Ibadan, where they feed voraciously on cocoa leaves and have been found in a kitchen garden on kohl-rabi.

The ground colour is slaty blue. The anterior of each segment, dorsally, has a well marked transverse half-hoop of reddish brown and thinner parallel lines. The head is yellow-brown, with eleven dark spots, eight of which are arranged as a horse-shoe curve surrounding the other three. The pupal period lasts 10 days.

In addition to the foregoing, certain other Lepidoptera were found in connection with cocoa, but little is known as to their real economic significance, so they are merely enumerated with brief notes.

NYMPHALIDAE: *Precis pelarga*, F.; a caterpillar of this butterfly was found in a cocoa bed at Ibadan.

LYCAENIDAE: *Lycaenesthes larydas*, Cram.; a pupa found in the cocoa nursery at Ibadan.

ARCTIIDAE: *Diacrisia curvilinea*, Walk.; caterpillars found on cocoa at Agege and Azumini.

NOCTUIDAE: *Plusia acuta*, Walk.; caterpillars were observed at Agege; and at Calabar they were active from May to July.

LYMANTRIIDAE: A swarm of larvae, attributed to this family, was found feeding on the growing tips of cocoa about 12 months old at Agege, on 6th July 1912.

GEOMETRIDAE: *Alcis divisaria*, Walk.; larvae were observed at Agege and Ibadan feeding on cocoa leaves in July and later.

PYRALIDAE: *Phryganodes hesusalis*, Walk.; a pupa was found rolled in a cocoa leaf at Ibadan.

The Curator at Calabar reported that green caterpillars (presumably NOCTUIDAE) damaged every cocoa plant over 1½ acres; syringing with Paris green kept them away for only 6 to 8 weeks.

From 61 caterpillars collected in the cocoa nursery at Ibadan, 21 were found to be *Diacrisia maculosa*, 7 *Prodenia litura*, 3 *Diacrisia* sp., 3 *Alcis ?divisaria*, 2 *Plusia acuta*, and 25 casuals. While this illustrates correctly that *D. maculosa* is the worst caterpillar pest and that *P. litura* is a poor second, it is not true for *Diacrisia* sp. or *Plusia acuta*, which are commoner than this one example shows. The number of casuals is striking and their cumulative effect most important.

At Calabar the commonest pest was *Prodenia litura* with *Plusia acuta* a good second. *Rhopalocampa forestan* was found only on one tree, about three years old, but the small swarm of one dozen was doing a great deal of harm. Whether

the species is to be regarded only as a destructive casual remains to be seen. The treatment for these pests should be similar to that recommended for the following insects.

Leaf-eating Beetles.

Adoretus hirtellus, Castn., was only noticed in the Western Province, at Lagos, Agege and Ibadan ; but it is known to be generally distributed in West Africa.

The beetle feeds on the leaves of cocoa and kola, eating only the soft tissue between the very small veins and if left alone will completely skeletonise a leaf. Leaves affected by this beetle can easily be distinguished by this feature (Plate XXVIII, fig. 2). Grasshoppers are not so particular, and make larger holes; while caterpillars usually commence operations at the edge of the leaf and consume the whole leaf substance. To watch the pest at work it is necessary to go with a lantern at night and look on the underside of the leaves. On quite young kola plants, with only half a dozen leaves, as many as four beetles have been observed chewing away steadily. They fly at night and are attracted to light. During the day, they lie hidden in the soil quite near the surface and within 3 inches of the base of the plants. Their greenish-brown colour and inactivity render them unobtrusive and liable to be overlooked. Though they were only found at first during July, there does not seem to be any off-season with them, as leaves bearing characteristic holes may be found at any time of the year.

While searching for the adults in the soil many chafer grubs about 1 inch long were found. They were more numerous than the beetles. Once, in July 1912, a white pupa and its cast larval skin were dug up. The larval skin was very similar to that of the chafer larvae, while the pupa was similar to the adult *Adoretus*. Unfortunately the pupa died, and though grubs were kept for a few months none pupated. It is probable that these were the larvae of this beetle, but further investigation is necessary.

This beetle was certainly one factor in retarding the growth of about 475 cocoa and 182 kola plants at the Government Model Farm, Agege. In the nursery at Ibadan any one passing could not but remark the severe damage caused by the pest.

Treatment of Leaf-eating Pests.

At Agege the caterpillars of *Diacrisia maculosa* were frequently observed to pass between the cocoa plot and an adjacent maize plot, feeding well in either, and their activity was remarkable. The juxtaposition to cocoa of a crop like maize, which provides abundant food and is difficult to work for caterpillars, is clearly a mistake.

At Calabar the nursery beds were surrounded by short thick grass and weeds and abundance of *Plusia acuta* caterpillars were found thereon and upon the young cocoa. Whether the grass and weeds provided food for the larvae is doubtful, but they certainly provided plenty of shelter, and the necessity for cleanly farming must again be emphasised.

At Onitsha no caterpillars were found. Whether there be any other reason or no, the fact remains that the beds received unremitting care and were kept beautifully clean from weeds, as were the surroundings.

In order to get the cocoa beds at Ibadan into as clean a condition as possible, so that future work would be facilitated, an agricultural pupil was deputed specially to look after them. His duties were to weed the beds and collect any caterpillars, and most important, rake carefully round the base of the plants to find any chafer beetles and grubs. These measures were repeated weekly for about eight weeks but were found only temporarily efficacious. Active caterpillars and flying beetles cannot be permanently defeated in this way.

Some spraying experiments were made to test what strength of insecticide may be applied with safety to young cocoa. Baskets of young plants two months and eight months old were sprayed with a mixture of Paris green and lime of twice and four times the normal strength. (Normal strength :—1 lb. Paris green, 2 lbs. lime, 200 gallons water.) Three applications, at intervals of a fortnight, were given. The time of the experiment was the dry season, during September, but the plants were kept very carefully shaded. None of them succumbed.

Plants treated similarly with twice the normal strength of lead arsenate, were similarly unaffected. (Normal strength :—1 lb. lead arsenate, 120 gallons water.)

In another spraying test at Ibadan, 12,500 cocoa plants were treated with a normal mixture of Paris green and lime, and 320 plants with lead arsenate. The insecticides were applied with Strawson's "Antipest" Knapsack Sprayers at a total cost of 11*s.* 6*d.*—including labour of two pupils for 42½ hours (10*s.*) and chemicals (1*s.* 6*d.*). The plants certainly benefited by the treatment, the effects lasting for quite a fortnight.

A similar test with cocoa and kola at Agege was inconclusive, owing to bad weather and the thickness of the shade plants.

The rules for combating leaf-eating caterpillars and beetles therefore resolve themselves into the following :—

1. Cleanly farming and the segregation of cocoa beds from maize.
2. A combination of hand-collecting and spraying. While weeding is being done in the nursery beds, troublesome insects should be collected at the same time and then destroyed ; subsequently the beds should be sprayed.
3. Unremitting watchfulness and care should be maintained.

The small amount of work necessitated at each short periodic examination of the beds pays better than using operations on a larger scale at rare intervals. It is not sound policy to allow plants to get into such a state that radical measures are imperative ; "prevention is better than cure."

Pod Borer.

It is regrettable that little opportunity was afforded for work upon this serious pest and also that the specimens found in the collection on assuming duty had suffered from the climatic effects to such an extent that identification was impossible, and even the generic name can only be hazarded (? *Myelois*).

The caterpillars of this Phycid moth are a feature at Agege ; but they have not been noticed from the south of the Eastern Province, where a considerable amount of cocoa is grown.

On opening cocoa pods left hanging on the trees, or lying on the ground, at Agege, the caterpillars were found, usually in large numbers, up to 120, meshed in a ravel of silk among dry brown powder and riddled seeds. They are light in colour, with a tinge of pink, and the intestine shows dark through the dorsum. They grow to one inch, but no specimens were bred through.

It does not require figures to illustrate or prove the ravages of this pest. Judging by the thousands of old pods left neglected on the trees and on the ground at Agege on the native farms, the damage done must be incalculable. It is not a cheering sight to the Economic Entomologist, and one can only wonder that cocoa succeeds as it does.

What is wanted is a wholesale clearing up and destruction of neglected pods. Till this is done it is very little good spraying growing pods with insecticides.

The whole question of entomological methods is discussed later at the end of the section on the insects of cocoa.

The following insects have also been observed to attack cocoa in Southern Nigeria, but little is yet known about them.

CERAMBYCIDAE. The larva of a Longicorn beetle does serious damage by boring in the trunk and branches. It is very common at Agege and has been noticed at Nzula, E. P. The adult is unknown.

LOCUSTIDAE: *Catantops ? vittipes*, Sauss., and a small green wingless grass-hopper do a small amount of damage by eating the leaves.

TRYPETIDAE: *Ceratitis punctata*, Wied., has been bred from cocoa pods at Olokemeji.

TINGIDIDAE: A species of *Monanthia* was found in large numbers at the growing tips of cocoa in July 1912 at Agege.

Scale-Insects.

The scales found on cocoa at Ibadan have been kindly determined by Prof. Newstead as *Pseudococcus virgatus* var. *madagascariensis*, Newst. A species found at Onitsha he has referred with some doubt to *Pseudococcus citri*, Risso.

Red Tree Ants.

These insects (*Oecophylla smaragdina longinoda*, Latr.) are not harmful to the cocoa trees, but they are a great nuisance when collecting ripe pods. Their numbers and their irritating bites cause the native collector to shirk his work. There is no easy way to get rid of them, but the best plan under the present state of things is to cut down the leaf nests and destroy them. For nests high up, long pruning secateurs are necessary. This carried on over thousands of trees is an unavoidably laborious business. If measures against the older and larger trees are not to be attempted, the young trees, which can be easily worked, should at least be attended to. But eventually some wholesale measures will have to be undertaken against these insects.

Snails and Slugs.

From Sapele (Central Province) it has been reported that the leaves of young cocoa suffer very much from the attacks of snails and slugs. *Limicolaria ? flammea*, the only snail found there during an entomological tour, was never observed doing any damage; no slugs were obtained. The matter needs more investigation.

BENEFICIAL INSECTS.

ICHNEUMONIDAE: A specimen of *Metopius discolor*, Tosq., was bred from a caterpillar of *Prodenia litura*, F.

TACHINIDAE: A fly of the genus *Sisyropa* was bred from a caterpillar of *Diacrisia maculosa*, Stoll.

CARABIDAE: Beetles of this family, *Oodes obesus*, Murray, *Platynus planaticollis*, Murray, and *Chlaenius westermanni*, Laf., were found in the soil at the base of cocoa plants in the Nursery at Ibadan. They probably will prove to be useful in destroying injurious insects.

In addition to the foregoing, certain insects of doubtful significance were found associated with cocoa.

ELATERIDAE: A species of *Alaus* was bred from a larva found in cocoa nursery beds at Ibadan, in July 1912.

RUTELIDAE: *Anomala denuda*, Arrow, found in soil near young cocoa at Agege, July 1912.

MELOLONTHIDAE: *Apogonia nitidula*, Thoms., found with the *Anomala* at Agege; and several species of *Trochalus* occurred in similar situations at Ibadan.

Termites are said to attack the roots of healthy cocoa trees, but no precise information is available, and it is of considerable importance that the matter should be investigated.

General Conclusions with regard to Cocoa Pests.

Cocoa is a most important asset to the Colony, ranking second in export value, and everything should be done to foster, encourage and improve its culture.

The entomological aspect of this matter cannot be stated without first discussing the present condition in Southern Nigeria of agriculture in general. The problems relating to cocoa are taken as typical, but the factors treated in the following remarks operate throughout every phase of agriculture.

In the first place, agriculture, as a calling, is unpopular. A native boy who has been to school aspires to be a trader or a clerk, preferably a Government clerk. He has the wit to know that a clerk has a better time than a farmer. To be a farmer in the opinion of a clerk, is to be a "bushman." Beyond a few pupils from the Agricultural Department there are practically no natives with any knowledge of European methods.

While recognising that the administrative work of a Colony must be carried on and that competent teachers must be trained, it is a mistake that these branches should absorb all educated natives. The most useful man in the

Colony is the farmer, and the policy of the Colony should be the production of such useful men. The experience of the Agricultural Department in the matter of pupils shows that good material cannot be obtained at the commencing wage of £15 a year, and there seems no other plan to obtain the required material than to enter into competition with other branches by offering as good inducements.

Like every other European idea introduced into a young Colony, agriculture requires first to train teachers. The Agricultural Department should be afforded fuller facilities for training natives who have attained, at least, the standard required of third class clerks.

Another method may be suggested. Bush boys who have not been to school might be indentured and trained in European methods till these become a habit. On reaching a high enough proficiency they might be allowed land to hold in trust to farm for themselves. These "model farms" should be subject to inspection by the Agricultural Department.

The particular working conditions of cocoa farming may now be discussed, with special reference to the cocoa-growing district of Agege.

The general condition of cocoa farms, at present, is bad. The most obvious defects are that they are bad because (1) the land is not thoroughly cleared and stumped; (2) the trees are not planted so that they may be readily worked; (3) the trees are not tended with even elementary skill; (4) decaying branches and pods are left on the trees and on the ground.

Briefly, the large cocoa farmers have attempted too much. The usual plea is that they cannot obtain labour. This is quite true. Labourers prefer to work on the railway or at the waterworks at Iju. But even if labour were plentiful and cheap, it is extremely doubtful whether that labour would be efficiently used.

The root question is undoubtedly the *thorough clearing and stumping of the land.* There are great objections to this. How is it possible to clear the land of such huge trees? Why should this generation trouble to do anything, the good of which it cannot see and will not reap?

Choice has to be made between cutting such trees down and destroying them—by fire or any other method; letting them rot away; leaving them to grow to be dealt with in future when they die. Clearing land is too big a matter for individual effort, and needs handling on a large scale. It is not within the province of such a report to give details, but a study of bush-clearing methods as practised in America and Australia would be suggestive. To allow logs and roots to rot naturally means that all manner of pests (termites and beetles particularly) and fungus diseases would be harboured. Leaving the trees alone is only postponing the question. When the trees do die, the amount of damage done to the cocoa farms in clearing may be very great, but the benefit reaped from the farm during the life-time of the trees has to be set against this.

In the event of the Government taking up the problem it should not be approached from the point of view of benefiting the large rich farmer only. If land be cleared for such a man he should pay in just proportion to the benefit he is likely to obtain, as also should subsequent owners of the land. So, without saddling posterity with a debt, it still is not deprived of its responsibilities.

The small farmer may now be considered. However much deserved credit be given the large farmers for their enterprise, it must be remembered that they have done well for themselves. But the bad condition of the farms and the methods in vogue at present do not simplify the question of increasing the value of cocoa growing in the Colony. Therefore any method which seeks to work towards this end through only the large farmer is not justified. Any legislative measures dealing with the proper ordering of cocoa farms, even leniently carried out, would simply wipe out the present farms. This however would not serve the end of fostering the industry. New developments in this direction should rather be along the line of encouraging small, workable, clean farms, worked by a man and his family. Such developments will produce better farms, because they take count of the personal factor. A native will work at what may be small, but what is his own, far better than if he were one of an army of hired servants labouring under a master.

A policy of this kind, though it may take many years to carry out, will surely be better than seeking to prop up the present state of haphazard farming methods. It may be necessary to create a special branch of the Agricultural Department, under an expert, whose whole time would be given to the work.

There will be some hope then in giving instructions in entomological methods. At present, practically nothing is known of the pests of grown cocoa trees in the Colony. Further entomological research on these is imperative and should be given a front place in any future work. In conjunction with this, the economic importance of termites should be determined.

But combative entomological methods must be viewed in their true relation to general agricultural methods. The Economic Entomologist in Southern Nigeria must be an Agricultural Officer first and an Economic Entomologist afterwards.

INSECTS AFFECTING MAIZE.

Cirphis ?phaea, Hmp.

The only specimens of the moth obtained were received from the Curator, Agricultural Department, Onitsha, and were damaged in transport. For this reason precise identification was rendered difficult. By comparison with specimens in the British Museum, it appears that the South Nigerian Army Worm is *Cirphis phaea.*

Reports of the presence of caterpillar swarms in April and May have been received from Erukute, Egbeda and Ibadan (W.P.), from Onitsha (C.P.), in September and October 1910, and from Calabar and Aro Chuku (E.P.) in April 1912. Further work will certainly show that these insects occur in many other places in the Colony.

To most people who have observed these swarms there seems something cryptic and uncanny about them. Innumerable larvae seem suddenly to appear from nowhere, to advance intently in crawling masses, leaving not a trace of grass or maize behind them, and then, just as suddenly, to disappear.

The larvae are dark green in colour, with darker longitudinal stripes. They reach a length of nearly 1½ inches. The plants upon which they feed are grasses, including the imported Bahama grass, and maize. These plentiful foods provide

abundant support for the innumerable caterpillars. The destruction of young maize is an important matter, for the maize replanted after the visitation of the caterpillars does not stand so good a chance of succeeding as the original crop, because of weather conditions.

The Yoruba realises perfectly well that this is a pest. It is called "rami-rami," the insect that comes when there is rain, and there is a traditional story concerning it.

The control of this pest demands vigilance. Early in April and, in the Eastern Province in August, the maize fields, lawns, and their surroundings should be examined for the small young caterpillars. If they are found, burning the grass or bush round the fields and lawns will destroy large numbers of them. Caterpillars which appear on the maize and lawn can only be prevented from doing extensive damage by spraying.

Calamistes praepallens, Hmp.

This moth is found in Southern Nigeria but no work was done upon it.

Calamistes fusca, Hmp.

This insect has only been briefly studied at Ibadan during October and November 1911. It is the Mealie Stalk Borer of South Africa and has been dealt with in the "Cape Agricultural Journal" for 1905.

The caterpillars bore into the maize stems, but the flowers are also frequented; as many as five have been found in one plant. They pupate in the stems, and the pupal stage lasts about a week. The larvae are brown dorsally, verging to pink laterally and a dirty cream ventrally. The head and posterior part are dark brown.

The presence of these pests in the centre of the stem usually causes the death of the plant, and a large number of plants are usually affected. But so little work has been done in Southern Nigeria upon this insect that suggestions for treatment cannot be given.

Noctuid Caterpillars in Cobs.

Little opportunity for a proper study of these insects was afforded. They are, however, very important and must be noticed, even though the name cannot be given. They were only observed at Ibadan during October 1912.

The larvae, which are numerous in the maize cobs, bore into the seeds and destroy them. Whole cobs are ruined in this way both in the field and store. The larvae are generally of a pinkish tinge and grow to 1 inch. The pupae are found among the stored grain, as also are the moths, which are of a sordid greyish brown.

The caterpillars are most voracious and destructive. Instead of confining their attentions to one seed at a time in the cob, they frequently eat a gutter through a whole line of seeds. Wood covers, $\frac{1}{4}$ inch thick, which were used on store tins containing seeds, were perforated by the caterpillars. Because of their numbers, size and appetite they are undoubtedly the worst maize pest, not excluding the universal grain weevils.

The field habits of the insect must be known better before measures can be suggested. Their destruction in the store is discussed later after other maize

pests have been noticed. The beetles, *Lagria villosa*, F., and *L. viridipennis*, F., and the locust, *Zonocerus variegatus*, L., are general leaf-eaters which also frequently damage maize.

Beetles that attack stored grain.

It is unnecessary to enlarge upon the habits and life-histories of these universal pests, foremost among which are, *Calandra oryzae*, L., *Tribolium castaneum*, L., *Laemophloeus pusillus*, Schön., and *Silvanus surinamensis*, L. They have been already well worked out, *Calandra oryzae* by the Entomological Department of India and the others by the Agricultural Department of the United States.

The main problem was the destruction of the pests. This is not very difficult if modern methods of storing and fumigating are employed, but it is a different matter where no facilities exist. A certain amount of work, though little, was done.

The natives often store maize in their huts on shelves above the cooking place, so that heat and smoke may circulate among the corn and, presumably, destroy any pests present. Experiments were therefore commenced to ascertain what practical value this method possessed for storing seed on a large scale for food and market. Cobs with the sheath leaves, stripped cobs, and seeds, to the amount of two tons, were placed in sacks, palm oil pots and securely lidded or sealed kerosene tins. They were stored in a rain-proof native hut about 24 ft. by 12 ft. and were arranged on shelves round the hut about 3 ft. and 5 ft. from the ground. Two hot fires were made or replenished in kerosene tins every day at 6 a.m., 8 a.m., 12 noon, 2 p.m., and 5 p.m. They were moved at intervals so that different portions of the maize received a due proportion of heat and smoke. One man was kept practically all day at the work.

During the last fortnight of the Entomologist's tour when the experiment was under his supervision, the temperature of the hut could not be raised to more than 85° F. Of course the temperature of the maize directly above the fires was hotter; indeed, in some cases it was scorched.

As much heat as could be obtained with safety was obtained, but without checking the ravages of the pests. Even the increased heat induced in the tightly packed seeds had no effect. The results, after continuing the work for a long time, might have improved. But even if they did, sufficient was done to show that the method was too cumbersome and risky for any problematic value it may possess. The same amount of labour put into fumigation methods would attain, far more efficiently, the end desired.

The fumigatorium which is being built at Ibadan is a most necessary building. But fumigation carried on under European control and the popularising of fumigating methods among the natives are different matters. Carried out willingly and with understanding, fumigation by the native ought to be a fairly simple matter. All the apparatus required is substantial air-tight receptacles, sufficient in size and number for the needs of the crop, and a quantity of carbon bisulphide. It is suggested that, as the making of air-tight wooden boxes in the Colony has been found very expensive, it may be cheaper to have the parts

ready for fitting sent out from England; or that metal tanks, similar to those used in the Colony for collecting rain-water, sent out from England in parts may be found preferable and cheaper.

Two courses are open to popularise fumigation. Either the farmer might be encouraged by demonstration and teaching to fumigate his own seed or public fumigatoria should be erected. It will be a reproach to the educated farmers of the Agege, Sapele and Aba districts if they do not set an example to all native farmers by using this certain method of preserving corn.

It would be interesting to ascertain whether a fumigatorium and store-house run by private enterprise would be a paying speculation.

INSECTS AFFECTING YAMS.

Prionoryctes caniculus, Arrow. (Plate XXV, fig. 10).

One specimen from Afikpo (E.P.) was sent by the Assistant Superintendent of Agriculture, Calabar, about February 1912. More specimens with information were received from Captain Richardson, District Commissioner, Kwale (C.P.), in July 1912.

Chafer grubs, of unknown species, were found destroying growing yams at Nzula, E.P.

The distribution of this insect is little known, and there was only one specimen in the British Museum.

Information from the aforementioned sources indicates that the beetles eat the yam vines and then descend to the young growing yams in the ground and destroy them. The fact of the beetles devouring the yams in the ground is interesting and unusual. Nothing is known as to the life-history of the species.

Further investigation will probably show this insect to be a serious pest. At Kwale several hundred plants on the prison farm were totally spoilt. A native interpreter at Uyo, E.P., gave information that for four years in succession a pest had attacked yams on the ground. From a very imperfect description it is possible that this species was meant.

It is not safe, with our present scanty knowledge, to detail measures for combating the insect. In the case of the prison farm it may be of good service before the yams are planted and while the ground is being prepared, to examine the soil for chafer grubs and destroy them. Old decaying logs and stumps should also be removed.

The fact that the beetles fly and probably descend from the bush will cause hand-picking to be only of temporary value. It will be worth while to try spraying the growing vines with a stomach poison.

Crioceris livida, Dalm. (Plate XXIV, fig. 7).

Larvae attacking growing yam vines were found at Uyo, E.P., in May 1912, while larvae and adults were found at Ibadan on 22nd June 1912. They are most probably the same insect. The grubs and adults eat the leaves and tender parts of the vines. In several cases the stem just below the soft growing tip was found almost chewed through. The insects at Ibadan disappeared by the 18th June 1913.

Breeding goes on in the Eastern Province during May. The time of commencement in the Western Province is not known, but it persists up till the end of June. The eggs are pinkish at first, then turning red-brown, about 2 mm. long, and sausage-shaped; they are laid on the underside of the leaves and on the stalks in clusters of about 6.

As is usual in this genus, the larvae cover themselves with their own excreta. In two instances full-grown larvae surrounded themselves with a white limy shelter enclosed in a fold of a leaf. But as no soil was put at the bottom of the glass vessels used for rearing them, it is probable that pupation may normally take place underground. Other food-plants are not known, and only one generation a year has been noticed.

This being the first occasion upon which observations have been made on the pest, its significance in the Colony is not known. If the numbers and damage at Uyo and Ibadan can be taken as typical, the insect must be watched for all over the Colony, lest a staple food crop like yam be subject to serious attack. The habit of the insect of chewing just below the leading shoots is particularly bad. This, coupled with the damage done to the leaves, seriously retards the growth of the vines. Fortunately at Ibadan the larvae disappeared, probably into the ground for pupation, and the plants survived, but not before a great amount of damage was done.

Spraying seems the best method of attack. This has been found quite successful against *C. asparagi* of the asparagus beds in America.

Apomecyna parumpunctata, Chev. The natives say that this beetle chops down the yam vines in the early morning. Vines were found cut off at a distance of 6–12 inches from the ground and beetles were found on the plants (Uyo, 18th May 1912), but the act of cutting was not observed.

Lagria villosa, F., *L. viridipennis*, F., and *Zonocerus variegatus* also attack the leaves of yams.

The following insects were found on yam, but are not yet known to do any appreciable injury:—a Chrysomelid beetle, *Oides ferruginea*, F., Ibadan, 2 vii. 12; a Pentatomid bug, *Cyclopelta dorsalis*, Walk., Uyo and Ikot Ekpene, 20 v. 12; and an undetermined scale-insect, *Pseudococcus* sp., Ibadan, vi. 12.

INSECTS AFFECTING FUNTUMIA RUBBER.

Glyphodes ocellata, Hmp. (Plate XXV, fig. 6).

This moth has only been detected at Ibadan, during September 1912. As it is found on *Funtumia elastica* in the Gold Coast, it is probably common in Southern Nigeria, wherever *Funtumia* is grown.

The caterpillars attack both nursery plants and grown trees alike, curling the leaves upon which they feed. Every plant in a nursery bed at Ibadan was attacked, and the caterpillars were prevalent upon 3-year old trees. Left unchecked, this is likely to become a pest.

The larvae have a wet green appearance, the intestine showing through the dorsum as a dark stripe. The pupae were found in the curls of the leaves, and the pupal stage lasts for at least 12 days.

Hand-picking the affected leaves, in the case of nursery plants, is not so good as spraying with Paris green, which was found to be quite successful. For

treating young grown trees a sprayer of good power is necessary. In the case of trees of the height of those grown in the communal plantations in the Central Province, spraying will be difficult, or even impossible. But it is conceivable that such high trees may not be attacked.

Nephele aequivalens, Walk.

The caterpillars, which were brown and 3 inches long, resembled twigs. They were found eating leaves of *Funtumia* at Ibadan only once, 27th October 1912. They do not therefore seem to be of much economic importance.

Thermopteryx elasticella, Hmp.

A poor specimen of a moth, reared from a *Funtumia* pod and found in the collection on assuming duty, seems to be of this species.

Physothrips funtumiae, Bagn.

These have been identified by Mr. R. S. Bagnall, of the University of Oxford. They are found in the flowers of *Funtumia*.

INSECTS AFFECTING PARA RUBBER.

At Agege, on 2nd July 1912, a huge Prionid larva, about 5 inches long, was found by the Mycologist. It was boring up a Para root which was seriously affected by fungus.

At Ugboha, C.P., in May 1912, a number of trees about 5 years old were found to be severely affected by borers. The insect, whether larva or adult, causing the trouble was not found and no information could be obtained. The holes were about $\frac{3}{8}$ inch in diameter.

INSECTS AFFECTING MAHOGANY.

At Calabar, mahogany trees (*Khaya senegalensis*) have suffered severely from the attacks of wood-boring lepidopterous larvae, about 100 trees in the avenue along the Old Calabar Road having been injured almost beyond recovery. These larvae (probably COSSIDAE) are of a dirty red colour and bore holes into the trunk and branches, causing the bark to strip off in circles and patches about 4 inches across (Plate XXVIII, fig. 1). The moth has not yet been reared.

Another lepidopterous larva was observed at Olokemeji to attack young trees at the tip of the leading shoots, boring through the cambium into the pith and proceeding downwards and out again. A large proportion of young trees just planted out were affected. The larva is grey and white, and attains a length of $\frac{3}{4}$ inch.

At Olokemeji, in January 1912, some of the young mahogany trees in the nursery were cut down by a nocturnal cricket, possibly *Brachytrypes*. Two species of bark-frequenting bugs of the family PENTATOMIDAE, *Atelocera raptoria*, Germ. and *A. stictica*, Westw., were also found on these trees, but their significance is not known.*

* [It is quite possible that these insects are beneficial; in Rhodesia the writer has seen a number of *A. stictica* feeding on a large Lasiocampid caterpillar (*Gonometa robusta*, Auriv.).—ED.]

INSECTS AFFECTING ARABIAN COFFEE.

The following insects and the notes upon them were found in the collection upon assumption of duty. All the specimens were taken on coffee at Olokemeji in 1909:—

CHRYSOMELIDAE: *Ootheca mutabilis*, Sahlb.
PENTATOMIDAE: *Antestia variegata*, Thunb.
COREIDAE: *Riptortus tenuicornis*, Dall.; found in great numbers.
FULGORIDAE: *Dictyopharina serene*, Stål.

INSECTS AFFECTING OTHER PLANTS.

Oil Palm. The common palm weevil, *Rhynchophorus phoenicis*, F., is the only insect recorded from this tree.

Coconut Palm. A weevil, *Temnoschoita quadrimaculata*, Gyl., has been found on the trunk of this tree at Olokemeji, in May 1909, but nothing is known as to its habits. The large Dynastid beetle, *Archon centaurus*, Burm., is suspected of damaging these palms.

Kola. A Rutelid beetle, *Adoretus hirtellus*, Castn. (Plate XXV, fig. 1) eats the leaves.

Okra (*Hibiscus esculentus*). Various cotton pests, such as *Cosmophila erosa*, *Zebronia phenice*, *Dysdercus superstitiosus* and *Oxycarenus dudgeoni*, are similarly injurious to Okra.

Cowpea. Three beetles (*Lagria villosa*, F., *L. viridipennis*, F., and *Monolepta* sp.), a locust (*Zonocerus variegatus*, F.) (Plate XXVII, fig. 2), and the larva of moth (*Azazia irrorata*, F.) have been observed to eat the leaves of this plant.

Poinciana regia. A Bostrychid beetle, *Apate terrebrans*, Pall., bores into the trunk of these shade trees and eventually kills them; most of the trees at Ikom station are affected. The insect has also been noted at Abakaliki, E.P. The Poincianas are sometimes stripped of their leaves by the caterpillars of a Psychid moth.

The following insects attack plants of several different kinds:—

Zonocerus variegatus, L.

These locusts have been found in all three provinces. They occur in swarms but never to the same extent as migratory locusts.

Both the young wingless forms and adults feed openly on the leaves of cotton (Plate XXVI), yam, maize, pumpkin, cassava and cowpea. No insect has been met with in Southern Nigeria with such an omnivorous taste, and this list of food-plants will certainly be lengthened by further observation.

Their boldly contrasted colours have evidently a warning significance. Evidence of this is afforded by the fact that a young English terrier, fresh from home, made an excellent meal on them and afterwards was violently sick. Pinned specimens emit a very unpleasant smell.

All stages of young were found towards the end of October 1911, at Ibadan, and, in March 1912, in the Central Province. The breeding season is probably, therefore, quite long.

Facts about the extent of damage done by these insects are badly needed. All that can be said at present is that they make extensive inroads into whatever crop they attack.

Opportunity for the study of the pest has been so small that it would be premature to make detailed suggestions as to methods of control, but information has been obtained that Paris green dusted on the plants proved a successful measure. Spraying with a stomach poison, however, is likely to prove more useful.

Lagria villosa, F., and *L. viridipennis*, F.

These bettles are common all over the Colony, all the year round. They have been found in numbers upon the leaves of yam, cowpea and even on cotton. Their economic importance is worth attention in future work.

Conclusion.

An economic entomologist has two aspects of his work to keep in view, the research and the instructional. The experiences of a single tour indicate that the most necessary entomological work at present is research.

The particular problems most likely to repay attention are, the control of the pests of cocoa and kola and the question as to the economic significance of termites. Cocoa, as the crop second in export value and with great possibilities, naturally comes first; for fortunately, the most valuable agricultural asset of the Colony, the oil palm, is strikingly free from pests. Kola to the amount of £68,245 is imported into the Colony, which is quite capable of growing its own. Yam and maize, because they are two staple native food crops, are next in importance.

It is likely, by now, that a scheme has matured whereby native school teachers may be given a course in "School Farming" at the Agricultural Station, Ibadan. This course will include lessons on the importance of insects to agriculture. In this way the native boys in the schools will be reached and shown the value of modern methods of agriculture.

At present, because of the conditions of native farming and our deficient entomological knowledge of the Colony, it is of no use to lecture to native farmers and agricultural societies. Entomological instruction cannot be given, nor the confidence of natives gained, till a great deal more pioneer research has been accomplished, so that entomological control methods can be demonstrated to be of economic value. And this work cannot be prosecuted unless the entomologist is provided with a laboratory and adequate apparatus and allowed to work freely and unhampered.

The ready help of the following gentlemen in the preparation of this report is acknowledged with thanks :—The specialists of the Natural History Branch of the British Museum ; Mr. F. V. Theobald, South Eastern Agricultural College, Wye, Kent ; and Mr. R. S. Bagnall, Hope Department of Zoology, University of Oxford. Particularly is mentioned the assistance of Mr. Guy Marshall, Director, Imperial Bureau of Entomology, British Museum.

Grateful witness is borne of the sympathy, encouragement and assistance of Professor H. Maxwell Lefroy, of the Imperial College of Science and Technology, London.

APPENDIX.

Note on the Value of Agricultural Products exported from Southern Nigeria.

(*From Trades Statistical Abstract, No.* 2, *for* 1911.)

Crop.	Value as Export.
	£
Products of Oil Palm	4,221,999
Cocoa	164,664
Rubber	125,842
Products of Cotton Plant	71,382
Mahogany	55,575
Kola Nuts	2,377
Products of Coconut Palm	1,755
Coffee	225

Maize, cassava and yam are staple crops grown for native consumption.

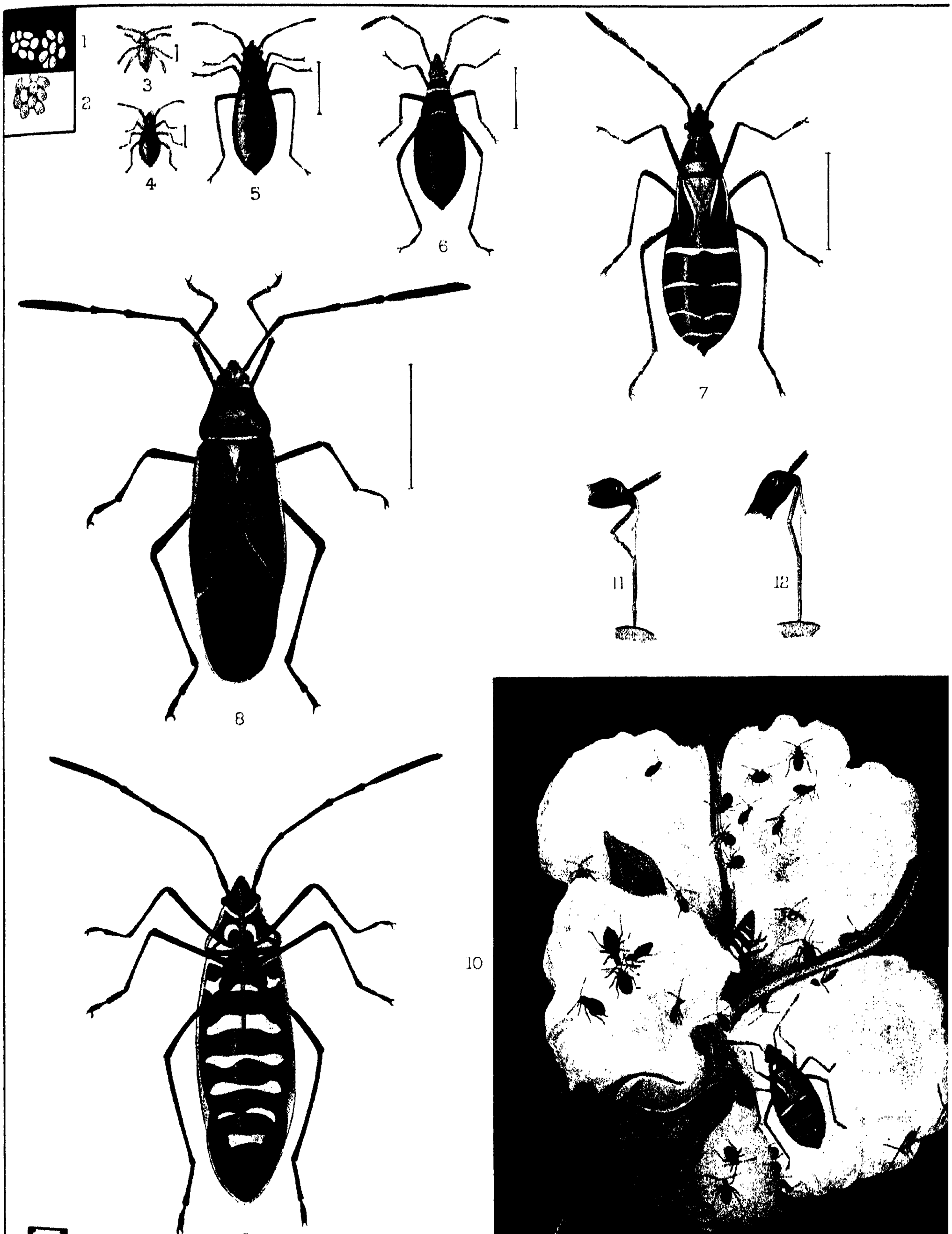
EXPLANATION OF PLATE XXIII.

Red Cotton Stainer.

(*Dysdercus superstitiosus*, F.)

Fig. 1–2. Eggs of *D. superstitiosus.*
3–6. The four larval stages.
7. The nymph.
8. The adult, upper side.
9. ,, under side.
10. A cotton boll covered with young Stainers.
11. The position of the proboscis when sucking.
12. The proboscis in the act of withdrawal.

32306

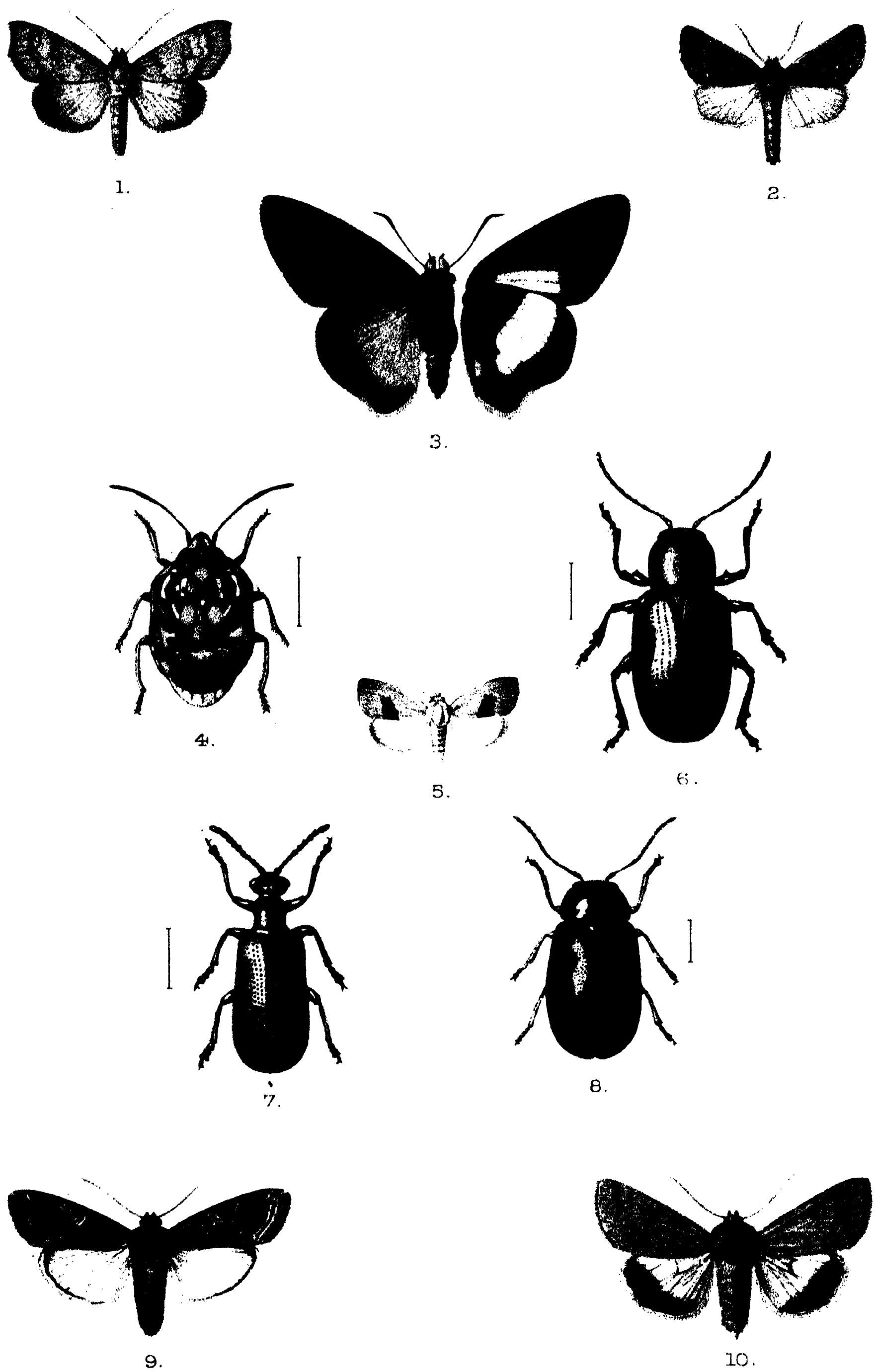


Bale & Danielsson, L^td.

A RED COTTON-STAINER (*Dysdercus superstitiosus*, F.).

EXPLANATION OF PLATE XXIV.

Fig. 1. *Cosmophila erosa*, Hb.
2. *Diparopsis castanea*, Hmp.
3. *Rhopalocampta forestan*, Cram.
4. *Antestia variegata*, Thunb.
5. *Earias biplaga*, Walk.
6. *Syagrus calcaratus*, F.
7. *Crioceris livida*, Dalm.
8. *Ootheca mutabilis*, Sahlb.
9. *Prodenia litura*, F.
10. *Chloridea obsoleta*, F.

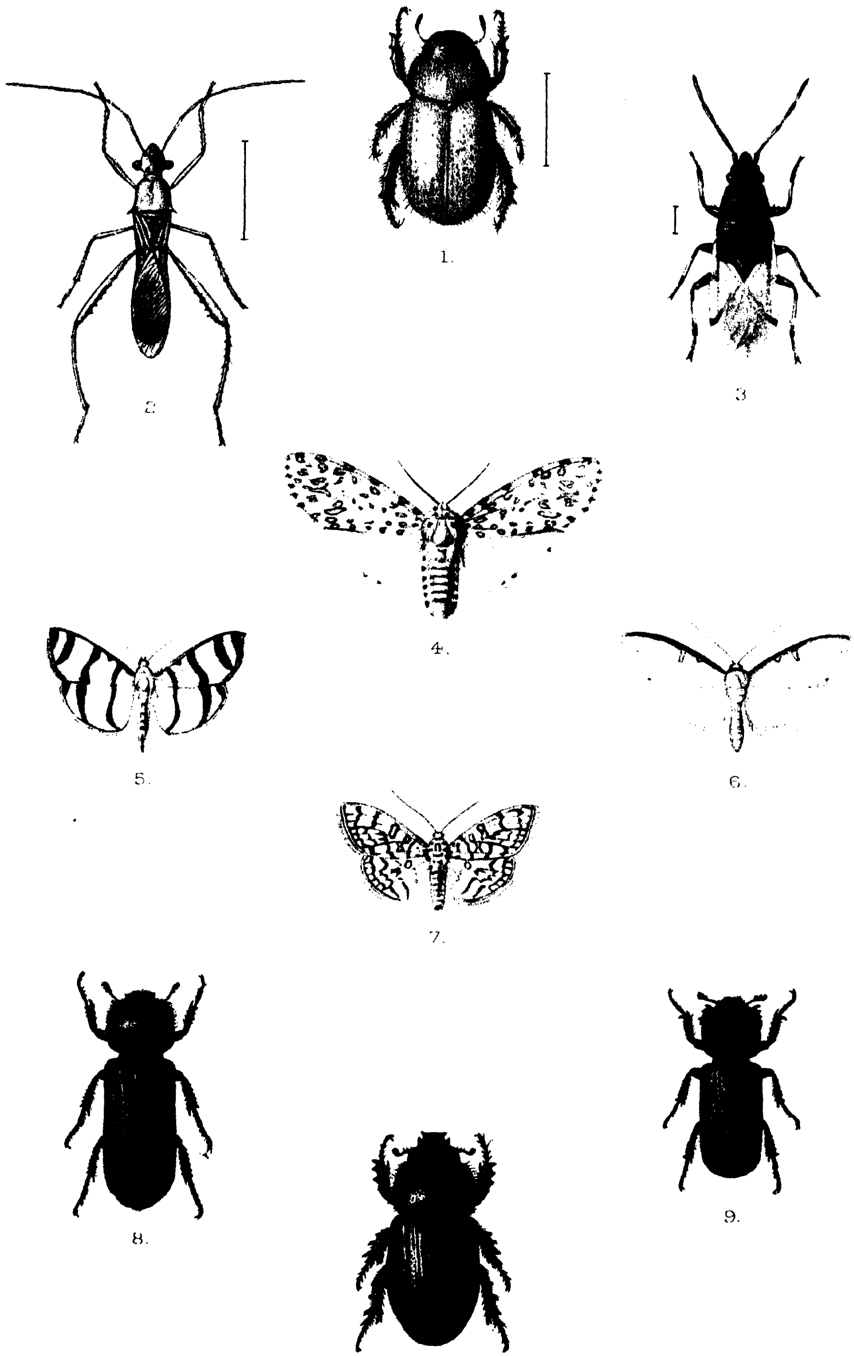


Bale & Danielsson, L^td

AGRICULTURAL PESTS IN SOUTHERN NIGERIA.

EXPLANATION OF PLATE XXV.

Fig. 1. *Adoretus hirtellus*, Castn.
2. *Riptortus tenuicornis*, Dall.
3. *Oxycarenus dudgeoni*, Dist.
4. *Diacrisia maculosa*, Stoll.
5. *Zebronia phenice*, Cram.
6. *Glyphodes ocellata*, Hmp.
7. *Sylepta derogata*, F.
8. *Apate terebrans*, Pall. ♀.
9. *Apate terebrans*, Pall. ♂.
10. *Prionoryctes caniculus*, Arrow.



Bale & Danielsson, Ltd.

AGRICULTURAL PESTS IN SOUTHERN NIGERIA.

Effect of *Zonocerus variegatus* on Cotton plant.
A few of the pests may be seen on the upper leaves.

FIG. 1. Effect produced on a Cotton plant by the leaf-rolling caterpillars of *Sylepta derogata*.

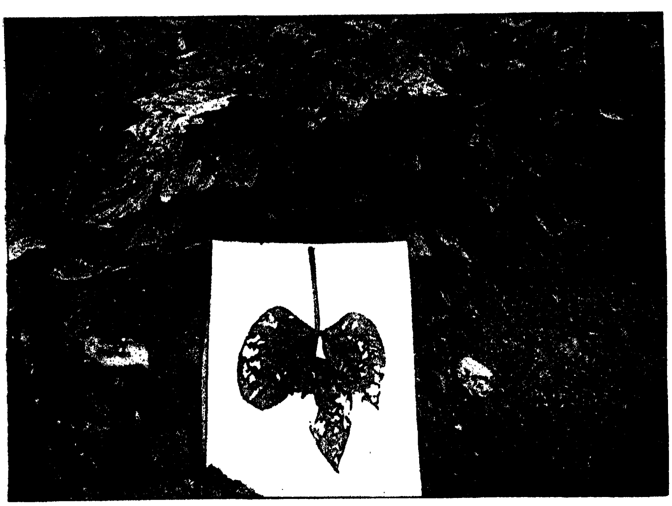


FIG. 2. Effect of *Zonocerus variegatus* on Cowpea.

FIG. 1. Trunk of African Mahogany (*Khaya senegalensis*) bored by Lepidopterous Larvæ.

FIG. 2. Effect of Night Beetle (*Adoretus hirtellus*) on Cocoa leaves.

(The right-hand leaf below shows effect of Caterpillar attack.)

NEW SYNONYMY IN ORIENTAL CULICIDAE.

By F. W. EDWARDS, B.A., F.E.S.

(Published by permission of the Trustees of the British Museum).

For the past two years the writer has studied the Oriental CULICIDAE at intervals, with a view to preparing a tabular synopsis of the species. During this time it has become evident that a large number of names will have to be rejected or changed in some way, and it seems desirable to call attention at once to some of these proposed changes, as it will inevitably be a considerable time before the thorough revision of the Oriental mosquitos which the writer has in view can be published. The present paper is intended merely to deal with nomenclatorial questions, points of systematic interest being introduced only in so far as they are necessary to explain or justify the writer's conclusions. The classification here indicated may be taken as approximately final, but the limits of certain genera and their arrangement may ultimately require modification, while their number may not improbably have to be reduced. Over 80 specific names are here for the first time definitely sunk, while the probable synonymy of 8 or 10 others is suggested. On the other hand two new names are proposed owing to the preoccupation of the original designation of the species.

Subfam. 1. CULICINAE.

Tribe 1. Anophelini.

So much systematic work has already been done on Oriental *Anopheles*, that comparatively few questions of nomenclature remain undecided, but the following synonymies appear so far to have escaped the notice* of writers on this group :—

1. **Anopheles tessellatus**, Theo.

Anopheles tessellatum, Theo., Mon. Cul. i, p. 175 (1901).
Anopheles punctulatus, Theo. (*nec* Dönitz), *l.c.*
Anopheles deceptor, Dönitz, Zeit. für Hygiene und Infect., xli, p. 60 (1902).
Myzomyia thorntoni, Ludlow, Can. Ent. xxxvi, p. 69 (1904).
Dactylomyia ceylonica, Newst. & Cart., Ann. Trop. Med. iv, p. 377 (1910).

This is a purely Oriental mosquito ; it is represented, however, in the Australasian region by the closely allied *A. punctulatus*, Dön. I have compared a specimen of *M. thorntoni* named by Dr. Ludlow with Dönitz's description and figure of *A. deceptor* and with Theobald's type of *A. tessellatum*, and find that there is no room for doubt as to their identity. *Dactylomyia ceylonica* is supposed to possess a "cylindrical-shaped tubercle or finger-like process projecting obliquely from the prothoracic region," but this is probably a purely accidental appearance, and though I have not examined the type I should conjecture that it is formed by scales on the front margin of the mesonotum. The description of *D. ceylonica* gives no other character by which it might be distinguished from *A. tessellatus*, and as the British Museum possesses a specimen of this species from

* Since this was written Dr. A. T. Stanton (Bull. Ent. Res. iv, 1913, p. 129), has given *A. deceptor* and *D. ceylonica* as synonyms of *A. tessellatus*.

Ceylon the synonymy is in the highest degree probable. Stanton has recently stated (J. Lond. Sch. Trop. Med., ii, 1912, p. 6) that James and Liston's *Nyssomyzomyia punctulata* is also the same as *A. tessellatus*.

2. **Anopheles kochi**, Dönitz.

Anopheles kochi, Dönitz, Insecten-Börse, xviii, p. 1 (1901).
Cellia flava, Ludlow, Can. Ent. xl, p. 32 (1908).

Specimens named by Dr. Ludlow have recently been received, and on comparison with the British Museum series proved to be normal *A. kochi*. James' *Christophersia halli* is already recognised as a synonym of this species.

2a. **Anopheles christophersi**, Theo.

Anopheles christophersi, Theo., Proc. R. Soc. lxix, p. 378 (1902).
Myzomyia mangyana, Banks, Phil. J. Sci. i, p. 991 (1906).
Myzomyia funesta, Ludlow (*nec* Giles), Can. Ent. xxxvii, p. 135 (1905).

Theobald described the female palpi of *A. christophersi*, as having "two broad apical white bands and a narrow one near the base," and an examination of the type shows that this is perfectly correct, and that the species is quite distinct from *A. listoni*, Liston; on the other hand it is evidently the same as *M. mangyana*, Banks, which is represented in the British Museum by a female cotype. I have recently had an opportunity of examining some specimens from the Philippine Islands named *Myzomyia funesta* by Miss Ludlow. These are in reality *A. christophersi*, and it may therefore be presumed that *A. funestus* is not known from that region.

Tribe 2. **Megarhinini.**

Toxorhynchites, Theo.

Mon. Cul. i, p. 244 (1901).

3. **Toxorhynchites immisericors**, Walk.

Megarhinus immisericors, Walker, Proc. Linn. Soc. London, iv, p. 90 (1860).
Megarhinus gilesi, Theo., Mon. Cul. i, p. 227 (1901).
Toxorhynchites argenteotarsis, Ludlow, Can. Ent. xxxviii, p. 367 (1906).
Worcesteria grata, Banks, Phil. J. Sci., i, p. 779 (1906).
(?) *Megarhinus subulifer*, Dol., Nat. Tijd. Ned. Ind. xiv, p. 382 (1857).

This is a variable species, but the variation seems to me to be quite continuous; it is noticeable chiefly in the amount of white on the mid tarsi of the female and in the markings of the underside of the abdomen. The cross-veins also are very variable. There is no evidence to show that the palpal differences given by Theobald between *immisericors* and *gilesi* are really specific, nor can any other constant difference between them be discovered. I have not examined a specimen of *T. argenteotarsis*, but the description is quite full enough to warrant the assumption that it is only a form of *T. immisericors*. A male of *W. grata*, named by Banks, is in the British Museum, and I have therefore been able to

ascertain with certainty its identity with *T. immisericors*. There is nothing in Doleschall's inadequate description of *M. subulifer* to separate it from *T. immisericors*, and if this species is found to occur in Amboina the older name *subulifer* will have to be used for it. Doleschall, however, described quite a different species (*M. amboinensis*) which he afterwards considered to be the male of his *M. subulifer*; if his opinion was correct, *M. subulifer* is distinct from *T. immisericors*, and on account of this possibility the name under which this species is now widely known is retained for the present.

4. **Toxorhynchites quasiferox** (Leic.).

Teromyia quasiferox, Leic., Cul. of Malaya,* p. 51 (1908).

Toxorhynchites javaensis, Theo., Tijd. v. Ent. liv, p. 233 (1911).

If Theobald had seen Leicester's work he could hardly have failed to recognise that he was redescribing *T. quasiferox*. The only difference discoverable in the descriptions is doubtless due either to slight inaccuracy in Theobald's observations, or to fading after death. The caudal tuft of *T. javaensis* is described as follows : "apical segment with a dense tuft of bright orange chaetae, some short black ones at the sides of the previous one and some orange ones on the next." In *T. quasiferox* the black hairs on the penultimate segment are quite as long as the orange ones, and there are orange hairs at the base of this segment, not on the apex of the sixth. The basal abdominal segments of the British Museum specimens of *T. quasiferox* have faded to an "apple-green" as in *T. javaensis*. There are a number of small but constant differences (*e.g.* the white tip to the front tibiae), which need not be here enumerated, between this species and *T. immisericors*.

5. **Toxorhynchites magnificus** (Leic.).

Teromyia magnificus, Leic., Cul. of Malaya, p. 54 (1908).

Teromyia funestus, Leic., Cul. of Malaya, p. 58 (1908).

An examination of the type male of *T. funestus*, presented by Dr. Leicester to the British Museum, shows that his description was slightly inaccurate. According to this description "all the legs [apart from the coxae, are] brilliant purple, the only attempt at banding being an imperfect band on the first [*i.e.* second] tarsal joint of the hind legs." In the type there are however distinct traces of white marks on the under sides of the hind tibia and metatarsus in exactly the same positions as in *T. magnificus*. In addition to this, the scales of the mesonotum and first abdominal segment now appear coppery and not greenish, but this is doubtless due to *post mortem* changes ; all the specimens of *T. magnificus* have these scales metallic greenish, as described both for this species and for *T. funestus*. I therefore conclude that the specimen described as *T. funestus* is really only a dark form of *T. magnificus*. The commencement of the caudal tuft is white in both.

---

* In : Studies from Institute for Medical Research, Federated Malay States, Vol. 3, Part 3. Throughout this paper Leicester's work is quoted as above for the sake of brevity.

Tribe 3. **Culicini.**

(a) *Aëdes Group.*

PARDOMYIA, Theo.

Mon. Cul. iv, p. 280 (1907).

6. **Pardomyia aurantia,** Theo.

Pardomyia aurantia, Theo., Mon. Cul. iv, p. 280 (1907).
Ekrinomyia aureostriata, Leic., Cul. of Malaya, p. 71 (1908).

In Dr. Leicester's collection in the British Museum are 3 ♂ and 4 ♀ cotypes of *E. aureostriata*; the females agree exactly with the type of *P. aurantia.* This genus closely resembles *Mucidus* except in the scaling and the shorter female palpi.

MUCIDUS, Theo.

Mon. Cul. i, p. 268 (1901).

7. **Mucidus laniger** (Wied.).

Culex laniger, Wied., Dipt. Exot. i, p. 9 (1821).
Mucidus mucidus, Leic. (*nec* Karsch), Cul. of Malaya, p. 69 (1908).

This much resembles the true *M. mucidus*, but the second joint of the hind tarsi is entirely brown, instead of being white with a brown tip.

ARMIGERES, Theo.

Mon. Cul. i, p. 322 (1901).

Descoidya, Blanch., C. R. Soc. Biol. liii, p. 1046 (1901).
Desvoidea, Theo., Mon. Cul. iii, p. 134 (1903).
Blanchardiomyia, Brun., Rec. Ind. Mus. iv, p. 440 (1912).

Although the name *Armigeres* appears to be meaningless, there seems no reason why it should not be used, as there is no risk of confusion with *Armiger*, which is not the same word. Blanchard's *Desvoidya*, on the other hand, is preoccupied by *Desvoidia* (Meade, 1892), and on this account Brunetti proposed the name *Blanchardiomyia* for the present genus. It is interesting to notice how an error committed by one author becomes perpetuated. Theobald first spelt Blanchard's name wrongly (as above); later when compiling his fascicle of the "Genera Insectorum" he relies on his previous work, and, noticing the error in spelling, attributes it to Blanchard instead of to himself; Brunetti subsequently copies this inaccurate statement. This genus is regarded (for the present at least) as distinct from *Stegomyia*, owing to the peculiar structure of the larvae and of the male genitalia. I can discover no definite character, however, by which the female adults can be distinguished from *Stegomyia*, *Ochlerotatus*, or *Aëdes.*

8. **Armigeres joloensis** (Ludlow).

Desvoidea fusca var. *joloensis* Ludlow, Can. Ent. xxxvi, p. 236 (1904).
Desvoidya jugraensis, Leic., Cul. of Malaya, p. 77 (1908).
Desvoidya joloensis, Theo., Mon. Cul. v, p. 143 (1910).

As Theobald suggests, this is not a variety of *A. fuscus*, but a distinct species. (It may be mentioned in passing that *A. fuscus* is also distinct by genital characters from *A. obturbans*). Ludlow's and Leicester's descriptions agree very well; Dr. Leicester at the time of writing was evidently unacquainted with Dr. Ludlow's existing description. There is a good series of the species in the British Museum.

9. **Armigeres apicalis** (Theo.).

Desvoidya apicalis, Theo., Rec. Ind. Mus. iv, p. 5 (1910).
Stegomyia crassipes, Theo. (*nec* Wulp), Mon. Cul. i, p. 320 (1901).

This is undoubtedly an *Armigeres*, although "general appearance" is the only guide in separating females of this genus from *Stegomyia*. Whatever Van der Wulp's *Culex crassipes* may be, it is almost certainly not this species. I have compared the Indian Museum type of *D. apicalis* with Theobald's specimens of *S. crassipes*.

STEGOMYIA, Theo.

Mon. Cul. i, p. 283 (1901).

10. **Stegomyia desmotes**, Giles.

Stegomyia desmotes, Giles, J. Trop. Med. vii, p. 367 (1904).
Stegomyia gracilis, Leic., Cul. of Malaya, p. 81 (1908).
Stegomyia albipes, Theo., Rec. Ind. Mus. iv, p. 11 (1910).

The type of *S. desmotes* is in bad condition, but is quite recognisable by the peculiar leg-markings, the only species at all resembling it in this respect being *S. sugens*. I have not seen the type of *S. albipes*; the description only disagrees with *S. desmotes* in that the claws of the female are described as being all simple. Since the structure of the female claws is occasionally subject to variation, no notice need be taken of this difference, even if Theobald's observation was correct.

11. **Stegomyia w-alba**, Theo.

Stegomyia w-alba, Theo., Ann. Mus. Nat. Hung. iii, p. 74 (1905).
Stegomyia imitator, Leic., Cul. of Malaya, p. 89 (1908).
Stegomyia minutissima, Theo., Rec. Ind. Mus. iv, p. 9 (1910).

There are some slight differences between the specimens which have been described under the above names, which I consider should not without strong evidence be regarded as of specific value. These differences are as follows: *S. w-alba* has the basal scutellar scales black, the apical ones white; *S. imitator* has the scutellar scales all white; *S. minutissima* has the scutellar scales black, some white ones occurring on the lateral lobes, and it also has the white markings

of the thorax less extensive than in the other two. I have seen only a single female of *S. imitator*, and have not examined the type of *S. minutissima*, but support is lent to the view here expressed by the fact that neither Leicester nor Theobald suggested differences between their species and *S. w-alba*. I have examined the type of *S. w-alba* among others which were kindly lent me by Dr. Kertész from the Buda-pest Museum.

12. **Stegomyia trilineata** (Leic.).

Hulecoetomyia trilineata, Leic., Entom. xxxvii, p. 163 (1904).
Howardina chrysolineata, Theo., Mon. Cul. iv, p. 218 (1907).

I have carefully compared the types and find that they are indistinguishable specifically. The palpi of the male are thin, upwardly-curved and practically devoid of hair-tufts, hence I include the species in *Stegomyia*. Some species of *Ochlerotatus* (e.g., *O. pseudotaeniatus*, Giles, and *O. gubernatoris*, Giles) have the male palpi only just perceptibly swollen apically, but these species have the apical joints bent downwards and provided with distinct hair-tufts, which justifies their inclusion in *Ochlerotatus*. The two genera, as has already been suggested, are very close, and a doubt may again be expressed as to whether the wisest course to take with regard to them may not be that adopted by Dyar and Knab of sinking both under *Aëdes*.

OCHLEROTATUS, Arrib.

Rev. Mus. La Plata, ii, p. 143 (1891).

13. **Ochlerotatus gubernatoris** (Giles).

Culex gubernatoris, Giles, J. Bombay Nat. His. Soc. xiii, p. 607 (May 1901).
Culex gubernatorius, Giles, Entom., xxxiv, p. 194 (July 1901).
Finlaya melanoptera, Giles, J. Trop. Med. vii, p. 367 (1904).
Lepidotomyia magna, Theo., Gen. Ins., Cul. p. 22 (1905).
Pseudocarrollia lophoventralis, Theo., Rec. Ind. Mus. iv, p. 12 (1910).

Giles' type of *C. gubernatoris* is in the British Museum, and though damaged, is quite recognisable. His figure of the species (Gnats, Ed. ii, pl. 14, f. 7) is inaccurate, as the white markings on the front of the thorax are of an altogether different shape. *Lepidotomyia magna* differs from the type of *O. gubernatoris* in the greater breadth of the white rings on the middle legs, but an examination of a series of specimens shows that this is a mere individual variation, as might be expected. Through the courtesy of Dr. Annandale and Mr. Gravely of the Indian Museum, I have been able to examine the type of *P. lophoventralis*, and find that without the least doubt it is simply a specimen of *O. gubernatoris*, in which the scales on the under side of the abdomen are rubbed up the wrong way, so as give a tufted appearance. This is still more the case with the type of *F. melanoptera* which has the tufts quite as well marked as in Giles' figure. This specimen, however, exactly resembles *O. gubernatoris* in all other respects, and so the long scales figured by Giles must either be regarded as an abnormality, or they may be normally present in a horizontal position, where they would be very difficult to see, especially if covered by other scales.

14. **Ochlerotatus niveus** (Ludlow).

Stegomyia nivea, Ludlow, J.N.Y. Ent. Soc. xi, p. 139 (1903).
Stegomyia pseudonivea, Theo., Ann. Mus. Nat. Hung. iii, p. 75 (1905).

S. pseudonivea was supposed to be distinguished from *S. nivea* "by the fore and mid ungues [of the female] being uniserrated and not simple, and by the femora being dark above, not white as in *nivea*." An examination of specimens shows that the teeth on the claws are very minute, and may easily have been overlooked by Miss Ludlow, apart from the fact that they may be variable in this species as in a few others. The description of *S. nivea* only states that the *hind* femora are white dorsally on the *basal two-thirds*, and as this is also the case in all the specimens of *S. pseudonivea* in the British Museum, there can be no reasonable doubt about the synonymy given above.

15. **Ochlerotatus taeniorhynchoides** (Chris.).

Leslieomyia taeniorhynchoides, Chris., Paludism, no. 2, p. 68 (1911).
Pecomyia maculata, Theo. (*nec* Meigen), J. Econ. Biol. i, p. 24 (1905).

Meigen's *Culex maculatus* is an *Ochlerotatus*, and therefore Theobald's name is not available for this species. There are two slight discrepancies in the descriptions of Theobald and Christophers: (1) Theobald states that there are both "flat" and "narrow-curved" scales on each lobe of the scutellum, while Christophers says the middle lobe has "narrow-curved," the lateral ones "flat" scales. Very likely the scaling of the scutellum is variable, but I find on examination that there are really no flat scales on the middle lobe of the scutellum of Theobald's specimens. (2) Theobald describes the hind claws of the male as unequal, while Christophers says they are equal; also, according to Theobald the larger claws of the fore and mid legs of the male are unindentate, according to Christophers bidentate. In this case Theobald's observations are certainly correct for his specimen, so that unless this is another case of variation in the claws, the two species may possibly be distinct. If that can be proved to be the case Theobald's species will require renaming, but for the present it is deemed better to regard it as synonymous with *O. taeniorhynchoides*.

16. **Ochlerotatus pipersalatus** (Giles).

Stegomyia pipersalata, Giles, Gnats, Ed. ii, p. 372 (1902) (♀ only).
Pseudograbhamia maculata, Theo., J. Bomb. Nat. Hist. Soc., xvi, p. 244 (1905).

Giles' description was a composite one, as the male and female types belong to quite different species. The male type differs from the female in all the points mentioned by Giles, but, apart from this, it has no obvious intermingling of black and white scales on the wings and legs, which Giles rightly regarded as of considerable taxonomic importance; his figure must represent a female and not a male wing. I have therefore chosen to restrict the name to the female type; the male will subsequently be redescribed and renamed. There is no doubt at all that Theobald's *Pseudograbhamia maculata* (known in both sexes) is the same species. *O. pipersalatus* much resembles *O. taeniorhynchoides*, but the scaling of the scutellum and the coloration of the thorax are quite different.

17. **Ochlerotatus imprimens** (Walk.).

Culex imprimens, Walk., Proc. Linn. Soc. v, p. 144 (1861).
(?) *Culex auratus*, Leic., Cul. of Malaya, p. 153 (1908).
Culicada suknaensis, Theo., Rec. Ind. Mus. iv, p. 21 (1910).

Walker's type, though damaged, is not by any means past recognition. Leicester's *C. auratus* is probably the same species, but as I have seen no specimen I only include it here provisionally. In any case Leicester's name is preoccupied by *Aëdes* (*Ochlerotatus*) *auratus*, Grabham (1906).

18. **Ochlerotatus stenoetrus** (Theo.).

Culex stenoetrus, Theo., Mon. Cul. iv, p. 395 (1907).
Culicada minuta, Theo., Mon. Cul. iv, p. 338 (1907).
Culicada eruthrosops, Theo., Mon. Cul. v, p. 299 (1910).
Culex pseudostenoetrus, Theo., Mon. Cul. v, p. 343 (1910).

There are some very slight differences between the above-mentioned forms, notably in the colour of the thoracic scaling, but nothing sufficient to distinguish them specifically. *C. pseudostenoetrus* is said by Theobald to differ from *C. stenoetrus* in having no pale apex to the palpi, and in the venation, but this is not true; even the type of *C. pseudostenoetrus* has a pale apex to the palpi, and the venation is quite similar to that of *C. stenoetrus*. *C. minuta* has a somewhat distinct appearance and a noticeably paler thorax, but can, I think, be included here with safety; otherwise it will require renaming, as the African *O. minutus* (Theo.) was described earlier.

19. **Ochlerotatus pulchriventer** (Giles).

Culex pulchriventer, Giles, J. Bomb. Nat. Hist. Soc. xiii, p. 608 (1901).
Howardina himalayana, Giles, J. Trop. Med. vii, p. 384 (1904).

Both types are in the British Museum, and are evidently conspecific.

20. **Ochlerotatus pallidostriatus** (Theo.).

Culex pallidostriatus, Theo., Mon. Cul. iv, p. 410 (1907).
Culex paruscelos, Theo., Rec. Ind. Mus. iv, p. 18 (1910).
Ochlerotatus ochraceus, Edw. (part), Bull. Ent. Res. ii, p. 250 (1911).

This species can be distinguished by the male genital characters from *O. ochraceus*, which appears to be confined to the Ethiopian region, as this is to the Oriental.

21. **Ochlerotatus mediolineatus** (Theo.).

Culex mediolineatus, Theo., Mon. Cul. ii, p. 113 (1901).
Culex trilineatus, Theo., Mon, Cul. ii, p. 105 (1901).

Types compared, leaving no room for doubt as to the synonymy.

22. **Ochlerotatus ostentatio** (Leic.).

Aioretomyia ostentatio, Leic., Cul. of Malaya, p. 193 (1908).
Pseudohowardina chrysoscuta, Theo., Mon. Cul. v, p. 228 (1910).

The male of this species being unknown, its location in *Ochlerotatus* rather than in *Aëdes* is purely a matter of conjecture.

AËDES, Mg.

Syst. Beschr. i, p. 13 (1818).

Skusea, Theo., Mon. Cul. iii, p. 291 (1903) (type *funerea*, Theo.).

Verrallina, Theo., Mon. Cul. iii, p. 295 (1903) (type *butleri*, Theo.)

Neomacleaya, Theo., Mon. Cul. iv, p. 238 (1907).

Aioretomyia, Leic., Cul. of Malaya, p. 185 (1908).

In the case of the first two synonyms quoted, Theobald gave no type species; they are here designated for the first time, the species being chosen which seems most likely to be the one on which Theobald based his conception of the genus. In each case some or all of the other species originally included are now recognised as belonging to different genera. The only one of the above "genera" which has the least claim to a separate existence is *Skusea*, which differs from typical *Aëdes* in having simple claws in the female. As in all other respects it is a true *Aëdes*, I hardly consider it entitled to subgeneric rank. Apart from the shortness of the male palpi, there seems to be some similarity between the members of the restricted genus *Aëdes* in general appearance and in the male genitalia, which are somewhat different from the usual *Ochlerotatus* type.

23. **Aëdes indicus** (Theo.).

Neomacleaya indica, Theo., Mon. Cul. iv, p. 238 (1907).

Skusea mediofasciata, Theo., Mon. Cul. iv, p. 544 (1907).

Pseudoskusea nigritarsis, Ludlow, Can. Ent. xl, p. 52 (1908).

Pseudoskusea mediolineata, Ludlow, Can. Ent. xl, p. 332 (1908).

The male being unknown, the position of this species in *Aëdes* is only presumptive. The types of *N. indica* and *S. mediofasciata* are precisely similar, and were both taken by the same collector, probably at the same place and time (they both bear the number 27). *P. nigritarsis* was suspected by its describer to be the same as *S. mediofasciata*; "*P. mediolineata*" was apparently a mere *lapsus calami* for *P. nigritarsis*.

24. **Aëdes butleri**, Theo., Mon. Cul. ii, p. 230 (1901).

Verrallina butleri, Theo., Mon. Cul. iii, p. 295 (1903).

Skusea diurna, Theo., Entom., xxxvi, p. 259 (1903).

Stegomyia hatiensis, Carter, Entom., xliii, p. 275 (1910).

The fore and mid claws in the type of *S. diurna* are distinctly toothed, not simple as Theobald states, and it is obviously the same as *Aëdes butleri*, which is very common in the Malay States. *S. hatiensis* is also undoubtedly the same, though it was described from very much damaged specimens.

25. **Aëdes uncus** (Theo).

Culex uncus, Theo., Mon. Cul. ii, p. 53 (1901).

(?) *Neomacleaya indica*, var. *simplex*, Theo., Rec. Ind. Mus. ii, p. 291 (1908).

(?) *Verrallina malayi*, Leic., Cul. of Malaya, p. 198 (1908).

As in most other species of this genus, the head is clothed mainly with flat scales. This is quite obvious in the type of *C. uncus*, which was wrongly

described by Theobald in this respect. *V. malayi* is, I believe, the same, but there are some slight differences in wing scaling. The name *malayi* had in any case best be dropped, to avoid confusion with *Aëdes malayi*, Leic. (which is a *Micraedes*, near, if not identical with *M. nigrescens* (Theo.)). Two males in Dr. Leicester's collection seem to have been undescribed by him, and are apparently assignable to this species.

26. **Aëdes fragilis** (Leic.).

Verrallina fragilis, Leic., Cul. of Malaya, p. 199 (1908).

Verrallina indecorabilis, Leic., Cul. of Malaya, p. 200 (1908).

The above synonymy is given as highly probable, but it is not absolutely certain, owing to the unfortunate fact that the specimens, in common with most of those in Dr. Leicester's collection, were unnamed when received at the British Museum; those which Dr. Leicester intended for type specimens merely bore a number (in addition to details as to capture), the significance of which is now lost. Types Nos. 54 and 55 however are almost certainly *V. fragilis* and *V. indecorabilis*. They at first sight differ considerably in the male genitalia, but on mounting these structures I found that the apparent difference was due to one specimen having lost its claspers. Descriptions of male genitalia are in any case inadequate, and if made from the dry specimen are apt to be very misleading, as I have found in studying the other species of *Aëdes* described by Dr. Leicester.

(b) *Taeniorhynchus Group.*

TAENIORHYNCHUS, Arrib.

Rev. Mus. La Plata, ii, p. 147 (1891).

27. **Taeniorhynchus brevicellulus,** Theo.

Taeniorhynchus brevicellulus, Theo., Mon. Cul. ii, p. 212 (1901).

Taeniorhynchus acer, Theo. (*nec* Walk.), Mon. Cul. ii, p. 211 (1901).

Chrysoconops pygmaeus, Theo., Rec. Ind. Mus. ii, p. 300 (1908).

Chrysoconops fuscopteron, Theo., Tijd. v. Ent. liv, p. 239 (1911).

This species seems to be subject to considerable variation, especially in the colour of the abdominal scales, some specimens having distinct purplish apical bands on each segment, while in others the abdomen is almost entirely yellow. I believe, however, that this variation is only individual. The species is a true *Taeniorhynchus*. Walker's type of *C. acer* is unrecognisable, but is certainly not a *Taeniorhynchus*.

MANSONIOIDES, Theo.

Mon. Cul. iv, p. 498 (1907).

28. **Mansonioides annuliferus,** Theo.

Panoplites annulifera, Theo., Mon. Cul. ii, p. 183 (1901).

Mansonia septempunctata, Theo., Ann. Mus. Nat. Hung. iii, p. 187 (1905).

Mansonioides septemguttata, Theo., Mon. Cul. iv, p. 499 (1907).

The types of *P. annulifera* and *M. septemguttata* belong indubitably to the same species. I have not seen the type of *M. septempunctata*, but there can be very little doubt that it is also the same.

(c) *Culex Group.*

CULEX, L.

Syst. Nat. Ed. x (1758).

29. **Culex bitaeniorhynchus**, Giles.

Culex bitaeniorhynchus, Giles, J. Bomb. Nat. Hist. Soc. xiii, p. 607 (May 1901).
Taeniorhynchus ager, Giles, Entom. xxxiv, p. 196 (July 1901).
Taeniorhynchus tenax, Theo., Mon. Col. ii, p. 198 (Nov. 1901).
Culex infula, Theo., Mon. Cul. i, p. 270 (Nov. 1901).
Grabhamia ambigua, Theo., Mon. Cul. iii, p. 248 (1903).
Grabhamia taeniarostris, Theo., Mon. Cul. iv, p. 299 (1907).
Oculeomyia sarawaki, Theo., Mon. Cul. iv, p. 515 (1907).
(?) *Taeniorhynchus domesticus*, Leic., Cul. of Malaya, p. 169 (1908).
(?) *Culicelsa abdominalis*, Taylor, Rept. Austral. Inst. Trop. Med., 1911, p. 53 (1913).

Most of the above synonymy has already been given under *C. ager*, but is printed again now in confirmation. I have recently discovered that Giles originally described his species as *Culex bitaeniorhynchus*, so the name *ager* must unfortunately be rejected. The abdomen bears a very variable amount of yellow scaling, which is occasionally present at the bases as well as at the apices of some of the segments. Leicester's *T. domesticus* is included here as a variety, but further experience may show that it is entitled to specific rank; however, the name cannot coexist with the much earlier *Culex domesticus*, Germ. *T. domesticus*, Leic., is only distinguishable from typical *C. bitaeniorhynchus* by its much blacker thorax.

30. **Culex sinensis** (Theo.).

Culex gelidus, var. *sinensis*, Theo., Mon. Cul. iii, p. 180 (1903).
Leucomyia sinensis, Theo., Mon. Cul. v, p. 313 (1910).
Culex sepositus, Leic., Cul. of Malaya, p. 152 (1908).
Taeniorhynchus tenax, Leic. (*nec* Theo.), Cul. of Malaya, p. 167 (1908).

This is not, as I previously considered, a variety of the preceding, but is a distinct species. It differs principally from *C. bitaeniorhynchus* in the entire absence of any pale scales on the wing; in the other species the wing is always more or less mottled with light and dark scales. There are also other differences between the two, *e.g.*, in the scaling of the legs. The type of *C. sepositus* is lost, but Leicester's description is unmistakeable.

31. **Culex epidesmus** (Theo.).

Taeniorhynchus epidesmus, Theo., Rec. Ind. Mus. iv, p. 22 (1910).
Taeniorhynchus luteoabdominalis, Theo., Rec. Ind. Mus. iv, p. 23 (1910).
Grabhamia ochracea, Theo., J. Econ. Biol. i, p. 35 (1905).

The name *ochraceus* is ineligible for this species, as Theobald had described a *Culex ochraceus* previously to his *Grabhamia ochracea*, and although the former species is now transferred to *Ochlerotatus*, its original location in *Culex* prevents

the subsequent use of the name for any other species of true *Culex*. This is a very striking species, and I have no doubt whatever concerning the synonymy. I have examined the Indian Museum type of *T. luteoabdominalis*, and find that Theobald's description is not quite correct. The legs of the type are somewhat rubbed, but do show traces of pale rings on the tarsi, such as are conspicuous in perfect specimens. The species is a true *Culex*, and is evidently related to *C. sinensis* and *C. bitaeniorhynchus*.

32. **Culex whitmorei** (Giles).

Taeniorhynchus whitmorei, Giles, J. Trop. Med. vii, p. 367 (1904).
Taeniorhynchus argenteus, Ludlow, Can. Ent. xxxvii, p. 98 (1905).
Leucomyia plegepennis, Theo., Mon. Cul. iv, p. 375 (1907).
Culex albus, Leic., Cul. of Malaya, p. 148 (1908).

The types of *T. whitmorei* and *L. plegepennis* are in good condition in the British Museum, which possesses a fairly good series of the species. Miss Ludlow has kindly presented some named specimens of *T. argenteus* to the Museum. Although I have not seen the type of *C. albus*, the species is so very distinct from all others that I have not the least hesitation in quoting the synonymy as above.

33. **Culex sitiens**, Wied.

Culex sitiens, Wied., Aussereur. zweifl. Ins. i, p. 543 (1828).
Culex impellens, Walk. (*nec* Theo.), Proc. Linn. Soc., iv, p. 91 (1860).
Culex annulirostris, Skuse, Proc. Linn. Soc. N. S. W., ser. 2, iii, p. 1737 (1889).
Culex microannulatus, Theo., Mon. Cul. i, p. 353 (1901).
Culex gnophodes, Theo., Mon. Cul. iii, p. 163 (1903).
Culex somaliensis, N.-L., Arch. Parasit. x, p. 254 (1906).
Culex ronaldi, Charm., Ann. Trop. Med. ii, p. 259 (1908).
Culex salus, Theo., Third Rep. Wellc. Lab., p. 256 (1909).

I have devoted considerable study to the small banded-proboscis species of *Culex*, and have come to the conclusion, after examining large series, that there are only three common Oriental species of this group, apart from such well-marked forms as those already referred to in this paper. Of these three species, *C. sitiens* may be recognised as follows: it is much blacker than the other two, and also somewhat larger; the scaling of the mesonotum is dark, but not uniform; the femora and tibiae have light and dark scales more or less intermixed; the first fork-cell in both sexes has its base slightly nearer the apex of the wing than that of the second; the long joint of the male palpi has a regular row of stiff translucent hairs projecting downwards and inwards. I have adopted the name *C. sitiens* for this species because Wiedemann's description fits it better than any other, while it certainly does not apply to the species which Theobald interprets as *C. sitiens*; Wiedemann gives the general colour as black, which would only apply to this species; moreover the size he gives would apply better to this than to either of the two following. Walker's type is of course in very bad condition and hardly recognisable, but I have included his *C. impellens* here because, contrary to Theobald's implication, the

first fork-cell in the type has its base slightly nearer the apex of the wing than that of the second. There are extremely slight colour differences between Oriental, Australian and African specimens, but as I find that the male genitalia are absolutely identical, I include *C. annulirostris*, *C. somaliensis* and *C. salus* as synonyms without any doubt. *C. gnophodes* and *C. microannulatus* are also evidently the same; Theobald's statement that the single specimen of *C. gnophodes* "can at once be told [from *C. microannulatus*] by the relative positions of the fork-cells and cross-veins, and by the abdominal banding and ornamentation" is quite erroneous, as there are certainly no such differences.

34. **Culex vishnui,** Theo.

Culex vishnui, Theo., Mon. Cul. i, p. 355 (1901) (♀ only).
Culex impellens, Theo. (*nec* Walk.), Mon. Cul. i, p. 362 (1901).
(?) *Culex microtaeniata*, Theo., Tijd. v. Ent., liv, p. 236 (1911).
(?) *Culex pseudoinfula*, Theo., Tijd. v. Ent., liv, p. 237 (1911).
(?) *Culex parvus*, Taylor, Bull. N. Terr. Austral., 1a, p. 27 (1912).

The chief distinguishing characters of this species are as follows: small, light brown in general appearance; scales of mesonotum light brown, but not uniformly so; femora and tibiae without any distinct intermingling of light and dark scales, but the latter (especially the middle pair) have a more or less evident pale lateral longitudinal stripe; bases of fork-cells almost level, or that of the first very slightly nearer the base of the wing than that of the second; male palpi with a row of hairs as in *C. sitiens*. The male genitalia are quite distinct from those of *C. sitiens* and also from those of *C. tritaeniorhynchus*, although they much resemble the last-named. *C. microtaeniata*, *C. pseudoinfula*, and *C. parvus* are included here as probable synonyms, as there is nothing in the descriptions which will definitely separate them from *C. vishnui*. I have not seen the types.

35. **Culex tritaeniorhynchus,** Giles.

Culex tritaeniorhynchus, Giles, J. Bomb. Nat. Hist. Soc. xiii, p. 606 (May 1901); id., Entom., xxxiv, p. 192 (July 1901).
Culex sitiens, Theo. (*nec* Wied.), Mon. Cul. i, p. 369 (Nov. 1901).
Culex annulus, Theo., Mon. Cul. i, p. 358 (Nov. 1901).
Culex vishnui, Theo., Mon. Cul. i, p. 356 (1901) (♂ only)
Culex biroi, Theo., Ann. Mus. Nat. Hung., iii, p. 82 (1905).

This species, though very much like the preceding, can readily be distinguished as follows: mesonotum clothed with dark brown scales, uniform in colour; scales of femora and tibiae dark brown (except on under side of former), no intermingling of light and dark scales, and no pale tibial stripe; base of first fork-cell in female distinctly nearer the base of the wing than that of the second, in the male the bases are about level; male palpi without the row of hairs found in the two species just dealt with. Although the hind tarsi have only faint pale rings, there is always some trace of these. The type (♀) of Giles' *C. tritaeniorhynchus* is in the British Museum, and serves to explain why this inappropriate name was given. Of the three bands on the proboscis described by Giles the one at the tip is really formed by the pale labella; the one near the base is merely due to some

scales being rubbed off. It is evidently the same species as Theobald's *C. annulus*, and from the description of *C. biroi* I should say there is no doubt that that is also the same. Theobald regarded some specimens as a distinct species (which he called *C. sitiens*) because he mistakenly supposed that there was no trace of "banding" on the hind tarsi; his description of the thoracic scales both of these specimens and of *C. annulus* is rather misleading, as the colouring is uniform over the greater part of the mesonotum. I have mounted the genitalia of the male type of *C. vishnui* and find them identical with those of other specimens of this species. The female specimen must be regarded as the type of *C. vishnui*, as Theobald gives it precedence.

36. **Culex halifaxii**, Theo.

Culex halifaxii, Theo., Mon. Cul. iii, p. 231 (1903).

Culex multimaculosus, Leic., Cul. of Malaya, p. 155 (1908).

I have compared the type of *C. halifaxii* with a series of Dr. Leicester's specimens of *C. multimaculosus*, and find they are the same. Apart from the difference in coloration between this species and *C. concolor*, there is a slight difference in the male genitalia, and also, according to Dr. Leicester, in the larvae, so that the two species are evidently distinct. This is rather surprising, as the exactly parallel difference in coloration between the African *C. tigripes* and its variety *fuscus* is not accompanied by any genital distinction, nor, as a matter of fact, can I detect any difference between the male genitalia of *C. tigripes* and *C. concolor*, although there is a constant difference in the neuration of the females. The specimens recorded by Theobald from Queensland as *C. tigripes* are really *C. halifaxii*, while those he has noted from various Oriental localities must be either this species or *C. concolor*. Both may, and generally do, have the femora distinctly spotted.

37. **Culex fuscocephalus**, Theo.

Culex fuscocephalus, Theo., Mon. Cul. iv, p. 420 (1907).

(?) *Culex minor*, Theo., Rec. Ind. Mus. ii, p. 298 (1908).

Culex taytayensis, Banks, Phil. J. Sci. iv, p. 545 (1909).

Culex luteola, Theo., Mon. Cul. v, p. 378 (1910).

I have compared the types of *C. fuscocephalus* and *C. luteola* with paratypes of *C. taytayensis* sent me by Mr. Banks, and find they are undoubtedly the same. The abdominal tergites are pale-scaled at their edges, the pale patch extending along the whole of the side of each segment, but broadening out somewhat towards the apex. The description of the abdomen of *C. minor* does not quite fit in with this, and as I have not yet examined a specimen this name is only included as a doubtful synonym.

CULICIOMYIA, Theo.
Mon. Cul. iv, p. 227 (1907).

This is quite a well-marked group, as apart from the scale characters which distinguish it from true *Culex*, there are certain characters of the male genitalia which seem to be peculiar to this group and common to all its members. It may therefore be justifiable to retain it as a distinct genus.

38. **Culiciomyia viridiventer** (Giles).

Culex viridiventer, Giles, J. Bombay Nat. Hist. Soc., xiii, p. 609 (May 1901).

Culex angulatus, Theo., Mon. Cul. ii, p. 324 (Nov. 1901).

Culex longifurcatus, Theo. (*nec* Becker), Rec. Ind. Mus. iv., p. 19 (1910).

Culex pseudolongifurcatus, Theo., Mon. Cul. v, p. 366 (1910).

All the types are in a good condition in the British Museum, and are unmistakeably all of the same species. The row of scales on the male palpi is quite well marked in this and in the two following species.

39. **Culiciomyia pallidothorax** (Theo.).

Culex pallidothorax, Theo., J. Econ. Biol. i, p. 32 (1905).

Culex albopleura, Theo., Mon. Cul. iv, p. 456 (1907).

Culiciomyia annuloabdominalis, Theo., Mon. Cul. v, p. 236 (1910).

The types of *C. pallidothorax* and *C. albopleura* are in the British Museum in sufficiently good condition for comparison. *C. annuloabdominalis* is unrepresented in the British Museum, but I have no doubt at all as to its identity. Theobald states in each case that the species may be distinguished from *C. fatigans* or *C. pipiens* by the more uniformly fawn-coloured thorax, but characteristically omits to compare *C. annuloabdominalis* or *C. albopleura* either with *C. pallidothorax* or with one another.

40. **Culiciomyia fusca** (Theo.).

Trichorhynchus fuscus, Theo., J. Bombay Nat. Hist. Soc. xvi, p. 240 (1905).

Culiciomyia inornata, Theo., Mon. Cul. iv, p. 227 (1907).

The above synonymy has already been referred to incidentally (Bull. Ent. Res. iii, p. 33, May 1912), but it is perhaps as well to restate it definitely.

41. **Culiciomyia minutissima**, Theo.

Culiciomyia minutissima, Theo., Mon. Cul. iv, p. 235 (1907).

Culiciomyia nigerrima, Theo., Mon. Cul. v, p. 233 (1910).

Melanoconion juxtapallidiceps, Theo., Mon. Cul. v, p. 456 (1910).

I have compared the types, which are in fairly good condition in the British Museum. The species may not be a true *Culiciomyia*, as the head scaling looks rather more like that of *Lophoceratomyia*; the male remains unknown.

LOPHOCERATOMYIA, Theo.

Ann. Mus. Nat. Hung. iii, p. 93 (1905).

Philodendromyia, Theo., Mon. Cul. iv, p. 623 (1907).

42. **Lophoceratomyia fraudatrix**, Theo.

Lophoceratomyia fraudatrix, Theo., Ann. Mus. Nat. Hung. iii, p. 93 (1905).

Lophoceratomyia variata, Leic., Cul. of Malaya, p. 121 (1908).

Paratypes of *L. fraudatrix* from the Hungarian Museum have been compared with a series of *L. variata* in the British Museum. There are some slight errors

in Leicester's description of this species (and of some others in the genus) which will be called attention to in a future paper. Meanwhile it may be noted that the curious structures on the antennae of the males evidently afford good specific characters in this group, and that in comparing specimens particular attention has been given to them.

42A. **Lophoceratomyia rubithoracis,** Leic.

Lophoceratomyia rubithoracis, Leic., Cul. of Malaya, p. 119 (1908).

Oculiomyia fulleri, Ludlow, Can. Ent. xli, p. 97 (1909).

Miss Ludlow has kindly sent me specimens of both sexes of her *O. fulleri*, and I have found them specifically identical with Leicester's co-types.

43. **Lophoceratomyia barkeri** (Theo.).

Philodendromyia barkeri, Theo., Mon. Cul. iv, p. 623 (1907).

Lophoceratomyia sylvestris, Leic., Cul. of Malaya, p. 125 (1908).

Theobald's *P. barkeri* was said to be described from two males, but although the single specimen in the British Museum has now lost its abdomen it is perfectly obvious that it is a female of the *Culex* group, and it is quite as evident that it is one of Theobald's specimens. It was simply the mistake as to sex which caused Theobald to erect a new genus for his insect. From certain peculiarities of the wing-scales, I judge *P. barkeri* to belong to the group *Lophoceratomyia*, and can see nothing to separate it from Leicester's *L. sylvestris*, though in the absence of a male it is practically impossible to distinguish some of the species. It seems best when possible to assign such names as *P. barkeri* to some recognised species, rather than leave them as mere catalogue names.

44. **Lophoceratomyia mammilifer,** Leic.

Lophoceratomyia mammilifer, Leic., Cul. of Malaya, p. 128 (1908).

Lophoceratomyia bicornuta, Theo., Rec. Ind. Mus. iv., p. 25 (1910).

Theobald gives quite good figures of the male antennae, which make *L. bicornuta* easily recognisable as the same as *L. mammilifer*.

45. **Lophoceratomyia brevipalpus,** Theo.

Lophoceratomyia brevipalpus, Theo., Ann. Mus. Nat. Hung. iii, p. 96 (1905).

Lophoceratomyia eminentia, Leic., Cul. of Malaya, p. 131 (1908).

Leicester states that *L. eminentia* differs from *L. brevipalpus* "in the absence of the mammiliform projection on the basal joint of the antenna, the untoothed mid ungues, and the golden scales on the sixth antennal joint." But (1) Leicester's type distinctly shows a blunt prominence on the inner side of the basal joint of the antennae, as figured by Theobald; (2) the larger claw of the mid legs of both specimens is untoothed, and the presence or absence of a tooth on the smaller claw may not be a specific character; (3) although Theobald does not describe the antennae in detail he gives a fairly good figure which shows that their structure is really exactly the same as in Leicester's type. I have therefore no hesitation in adopting the above-quoted synonymy.

Cyathomyia, Meij.

Ann. Jard. Bot. Buitenzorg, ser. 2, supp. iii, p. 921 (June 1910).

46. **Cyathomyia brevipalpis** (Giles).

Stegomyia brevipalpis, Giles, Gnats, Ed. ii, p. 384 (1902).

Melanoconion uniformis, Leic., Cul. of Malaya, p. 136 (1908).

An examination of the types (I have mounted the male genitalia of both) shows that these species are synonymous. To judge from the description, de Meijere's *C. jenseni* is a distinct species. Leicester attributes the first publication of *M. uniformis* to Theobald, but I have been unable to trace any earlier reference to it in literature.

Micräedes, Coq.

Proc. Ent. Soc. Wash. vii, p. 185 (1905).

Acalleomyia, Leic., Cul. of Malaya, p. 194 (1908).

47. **Micräedes obscurus** (Leic.).

Acalleomyia obscurus, Leic., Cul. of Malaya, p. 194 (1908).

An examination of the male genitalia shows that this species belongs to the *Culex* group, and the short male palpi place it in *Micräedes*.

Leicester's *Aëdes malayi* also belongs to this genus and lies extremely close to *M. nigrescens* (Theo.); there are however some slight differences in coloration and in the male genitalia.

(d) *Anomalous and Primitive genera.*

(Under this heading are included all those genera of Culicini which will not fit into any of the three foregoing groups.* With the exception of *Uranotaenia*, they are all small genera and have similar male genitalia of a simple type, though this fact alone may not indicate any close relationship between them.)

Theobaldia, N.-L.

C. R. Soc. Biol., 1902, p. 1331.

48. **Theobaldia glaphyroptera** (Schiner).

Culex glaphyropterus, Schiner, Fauna Austriaca, Dipt., ii, p. 628 (1864).

Pseudotheobaldia niveitaeniata, Theo., Mon. Cul. iv, p. 272 (1907).

I think there can be very little doubt that these two are the same species. A south European species is quite likely to occur in northern India.

Ficalbia, Theo.

Mon. Cul. iii., p. 296 (1903).

Etorleptiomyia, Theo., First Rept. Wellc Lab., p. 71 (1904).

Ingramia, Edw., Bull. Ent. Res. iii, p. 43 (1912).

I have compared the male genitalia of *Ficalbia minima*, Theo., with those of *Etorleptiomyia completiva*, Leic., and *Ingramia malfeyti* (Newst.) and find that

* Besides the ones specially mentioned, the genera *Mimomyia*, *Aëdomyia* and *Leptosomatomyia* occur in this section.

they are all of the same type, while in all these species the proboscis is strongly swollen apically in the male and distinctly so in the female ; it therefore seems justifiable to regard them all as belonging to one genus, in spite of the considerable differences in the male palpi. This course will at least call attention to their evident relationships, and no harm will be done even if the genera *Etorleptiomyia* and *Ingramia* be subsequently revived.

49. **Ficalbia minima,** Theo.

Uranotaenia minima, Theo., Mon. Cul. ii, p. 262 (1901).
Mimomyia minuta, Theo., Rec. Ind. Mus. ii, p. 301 (1908).

The description of *M. minuta* agrees very well with the type of *F. minima*, but I have not seen a specimen of the former. This species is hereby designated as the type of the genus *Ficalbia*, as Theobald did not select a type when describing the genus. The other species which was originally included (*F. simplex*, Theo.), does not belong here ; it is a true *Aëdes*.

50. **Ficalbia luzonensis** (Ludlow).

Oreillia luzonensis, Ludlow, Can. Ent. xxxvii, p. 101 (1905).
Etorleptiomyia luzonensis, Ludlow, Can. Ent. xxxviii, p. 185 (1906).
Etorleptiomyia completiva, Leic., Cul. of Malaya, p. 178 (1908).

Some slight discrepancies in the descriptions notwithstanding, I think there is very little doubt that *E. luzonensis* and *E. completiva* represent the two sexes of the same species.

URANOTAENIA, Arrib.

Rev. Mus. La Plata, ii, p. 163 (1891).

51. **Uranotaenia alboannulata** (Theo.).

Anisocheleomyia alboannulata, Theo., Entom. xxxviii, p. 54 (1905).
Uranotaenia trilineata, Leic., Cul. of Malaya, p. 204 (1908).

I have compared the types, but the species is so elaborately marked that even without this final test their specific identity would be unmistakeable.

52. **Uranotaenia nivipes** (Theo.)

Anisocheleomyia nivipes, Theo., Entom. xxxviii, p. 53 (1905).
Pseudouranotaenia triangulata, Ludlow, Can. Ent. xl, p. 331 (1908).
Uranotaenia nivea, Leic., Cul. of Malaya, p. 211 (1908).

Types of *A. nivipes* and *U. nivea* compared with one another and with specimens of *P. triangulata* named by Dr. Ludlow.

53. **Uranotaenia atra,** Theo.

Uranotaenia atra, Theo., Ann. Mus. Nat. Hung. iii, p. 114 (1905).
Uranotaenia ceylonica, Theo., Mon. Cul. v, p. 503 (1910).

I have examined the type of *U. atra*, among other species, through the kindness of Dr. K. Kertész of the Hungarian Museum. It is mouldy and rubbed and scarcely recognisable, but I could see nothing at all to separate it from *U. ceylonica*, and so the latter name may as well be rejected.

54. **Uranotaenia testacea,** Theo.

Uranotaenia testacea, Theo., Ann. Mus. Nat. Hung. iii, p. 113 (1905).
Uranotaenia falcipes, Banks, Phil. J. Sci. i, p. 1004 (1906).
Uranotaenia unilineata, Leic., Cul. of Malaya, p. 220 (1908).

The British Museum contains an example of *U. testacea* from Burma, named by Theobald, nine cotypes of Leicester's *U. unilineata,* and a paratype (?) of *U. falcipes* from the Philippine Islands named by Banks. In the last-named specimen the pleurae are not unscaled as stated in Banks' description, but have the usual line of blue scales distinctly present.

55. **Uranotaenia leicesteri,** nom. n.

Uranotaenia fusca, Leic., Cul. of Malaya, p. 227 (1908) (nec *U. fusca,* Theo., 1907).

This species is quite distinct from Theobald's *U. fusca,* and hence requires renaming.

ORTHOPODOMYIA, Theo.

Entom. xxxvii, p. 236 (1904).

Bancroftia, Lutz, Mosq. do Brazil (1904).

The species of *Orthopodomyia* and *Bancroftia* are identical in all structural details, and differ from practically all other CULICIDAE in the relative lengths of the front tibial and tarsal joints. I do not know the exact date of Lutz's work, and so use Theobald's name for the genus at present.

56. **Orthopodomyia anopheloides** (Giles).

Mansonia anopheloides, Giles, J. Trop. Med. vi, p. 315 (1903).
Orthopodomyia albipes var. *nigritarsis,* Leic., Cul. of Malaya, p. 177 (1908).
Orthopodomyia maculata, Theo., Rec. Ind. Mus. iv, p. 29 (1910).

I very much doubt whether *O. albipes* and *O. maculipes* are anything more than colour varieties of *O. anopheloides,* while as to the synonymy given above there can be no question. The types of *O. anopheloides* are in the British Museum. The Ceylon specimens referred by Mr. Theobald to *O. maculipes* are really only *O. anopheloides.* The three forms seem only distinguishable by the presence or absence of small black rings on the third and fourth joints of the hind tarsi.

Tribe 4. **Sabethini.**

The genera *Harpagomyia, Hodgesia, Topomyia, Zeugnomyia Mimeteomyia, Rachisoura,* and *Rachionotomyia* must be placed in this tribe, although none of their species possess postnotal setae. Their true relationship is shown in various ways, *e.g.,* the shortness of the hind tibiae, the structure of the male genitalia, the slightly keeled appearance of the postnotum, and the general appearance of the scaly covering; the species usually have metallic scales on the front part of the head. A reduction in the number of these genera will probably have to be made.

HARPAGOMYIA, Meij.

Tijd. v. Ent. lii, p. 165 (1909).

57. **Harpagomyia genurostris** (Leic.).

Malaya genurostris, Leic., Cul. of Malaya, p. 258 (1908).
Harpagomyia splendens, Meij., Tijd. v. Ent. lii, p. 165 (1909).
Harpagomyia coeruleovittata, Ludlow, Psyche, xviii, p. 131 (1911).

Dr. Ludlow suggested that her species might be distinguished from *H. splendens* by the scaling of the scutellum, but specimens in the British Museum from Batavia agree with her description, as also does Leicester's type. The African *H. trichorostris* is very similar, but differs in having a dark clypeus, that of the Oriental species being yellowish with a silvery pubescence.

HODGESIA, Theo.

J. Trop. Med. vii, p. 17 (1904).

58. **Hodgesia quasisanguinae**, Leic.

Hodgesia quasisanguinae, Leic., Cul. of Malaya, p. 230 (1908).
Hodgesia niveocaputis, Ludlow, Psyche, xviii, p. 130 (1911).

The descriptions correspond.

TOPOMYIA, Leic.

Cul. of Malaya, p. 238 (1908).

Pseudograhamia, Theo., Rec. Ind. Mus., iv, p. 26 (1910).

59. **Topomyia argenteoventralis**, Leic.

Topomyia argenteoventralis, Leic., Cul. of Malaya, p. 240 (1908).
Pseudograhamia aureoventer, Theo., Rec. Ind. Mus. iv, p. 27 (1910).

I have compared the types and find them identical.

RACHIONOTOMYIA, Theo.

J. Bombay Nat. Hist. Soc. xvi, p. 248 (1904).

Polylepidomyia, Theo., Ann. Mus. Nat. Hung. iii, p. 118 (1905).
Colonemyia, Leic., Cul. of Malaya, p. 233 (1908).
Sheiromyia, Leic., Cul. of Malaya, p. 248 (1908).
Squamomyia, Theo., Rec. Ind. Mus. iv, p. 28 (1910).

This genus may be defined as follows : Postnotum without setae, but with a distinct median longitudinal ridge ; hind tibiae distinctly shorter than either the front or middle ones ; prothoracic lobes well separated ; eyes touching for a long space ; proboscis slender, thin at the tip, longer than the abdomen ; male and female palpi short ; male with the antennae sub-plumose, the claws of the fore and mid legs unequal, the genitalia of Sabethine type. Leicester says that the larva is very hairy and "has a curious hooked chitinous process inserted on the

thorax at the posterior angle." *Rachionotomyia* somewhat resembles *Topomyia*, but in that genus the proboscis is shorter than the abdomen and slightly swollen at the tip, while the secondary male characters (plumose antennae and differentiation in the claws) are not developed. It is unfortunate that the name *Rachionotomyia* is the oldest one applicable to this genus, as it was mainly founded on a misconception (see note under *R. aranoides*).

60. **Rachionotomyia nitidiventer** (Giles).

Uranotaenia nitidiventer, Giles, J. Trop. Med. vii, p. 368 (1904).
Runchomyia philippinensis, Giles, J. Trop. Med. vii, p. 368 (1904).

This synonymy has already been given, but the species has not till now been referred to this genus, and the writer's statement (Ann. Mag. Nat. Hist., July 1911, p. 69) that *Phoniomyia bimaculipes* is another synonym is incorrect. *P. bimaculipes* belongs to this genus, but differs from *R. nidiventer* in having longer palpi.

61. **Rachionotomyia aranoides** (Theo.).

Wyeomyia aranoides, Theo., Mon. Cul. ii, p. 274 (1901).
Rachionotomyia ceylonensis, Theo., J. Bombay Nat. Hist. Soc. xvi, p. 248 (1904).
Skeiromyia fusca, Leic., Cul. of Malaya, p. 248 (1908).
Squamomyia inornata, Theo., Rec. Ind. Mus. iv, p. 28 (1910).

I have no doubt about the above synonymy, as I have examined all the types except that of *S. inornata*, and the species is a very distinct one owing to the scaly clypeus. The type of *W. aranoides* has the integument of the mesonotum of a darker colour than usual, but does not differ in any other way. Mr. C. S. Banks has placed the following common-sense note on the type of *R. ceylonensis* in the British Museum Collection: "It appears to me that this genus has been based upon a specimen which at some time, when soft, was so much mutilated that the contents of the body have exuded through the suture between the mesonotum and the scutellum or the scutellum and the metanotum and then have hardened, catching up small scales from the body surface, thus, when hardened, having somewhat the appearance of being covered with scattered scales. At any rate, the specimen is so much of a monstrosity that it is in no sense wise to use it as the type of a species, much less of a genus.—C. S. Banks, 21 Sept. 1908." Mr. Banks is evidently quite correct in his interpretation of the specimen.

62. **Rachionotomyia affinis,** nom. n.

Phoniomyia coeruleocephala, Theo., Mon. Cul. v, p. 577 (1910),
nec Colonemyia coeruleocephala, Leic., Cul. of Malaya, p. 233 (1908).

This may possibly be a variety of *R. aranoides* (Theo.) or *R. argentiventris* (Theo.); it differs from both in having the head bright blue in front view, from the former in having no scales on the clypeus, and from the latter in having brown instead of white scales on the prothoracic lobes.

Subfam. 2. CHAOBORINAE.

CHAOBORUS, Licht.

Arch. Zool. (Wiedemann's) i, p. 174 (1800).

63. **Chaoborus manilensis**, Schin.

Corethra manilensis, Schiner, Novara Reise, Dipt., p. 30 (1868).
Corethra asiatica, Giles, J. Bombay Nat. Hist. Soc. xiii, p. 610 (1901).

This species is the only common *Chaoborus* in the Oriental region, and is doubtless the one described by Schiner.

A PROPOSED METHOD OF CONTROLLING THE RAVAGES OF LEAF-EATING CATERPILLARS.

By Gerald C. Dudgeon.

Director of Agriculture, Egypt.

The subject which I propose to introduce is one which is of such very great importance in agricultural practice in different parts of the world that I trust it may not be out of place to give a brief account of the experiments in connexion with it, which we have been conducting in Egypt and which, although still incomplete, indicate very favourable results.

There is probably no country in the world more completely dependent for the prosperity of its inhabitants upon the success of its agriculture, than Egypt, nor is it probable that any other region is so generally well provided with the unvarying conditions to which such success is largely due.

The water supply is not, as in most other countries, dependent upon local climatic conditions, but is everywhere artificially controlled by means of an elaborate and well-organised system of canals, emanating from the Nile itself. In the flood water, which flows in these canals, a large amount of matter is held in suspension, which serves as a rich fertilising agent, annually renovating the soil wherever it is applied. Temperature and humidity exhibit practically no variation which can seriously affect agriculture, and the only uncertain factor which can exert a marked influence upon which results depend is the prevalence or absence of insect pests.

The isolated position of Egypt with respect to other countries places it in a favourable position to resist the natural introduction of such pests, but where, in spite of this, they obtain a footing, the absence of the natural enemies which control them elsewhere, as well as those nearly invariable climatic conditions, which I have mentioned before, constitute a powerful aid to their establishment and increase.

In this short paper I propose only to discuss one of the half a dozen important pests which exist in Egypt and to give a short account of the treatment which has recently been adopted to destroy the multitudes of a species of cotton leaf-eating caterpillar which occurs there.

This treatment promises such a great measure of success that, although it has not yet been adopted upon a very large scale, it is worthy of experiment in all parts of the world where similar pests are found.

The cotton leaf-eating caterpillar known as the "Cotton Worm" in Egypt is the larva of a Noctuid moth of the sub-family ACRONYCTINÆ and is scientifically termed *Prodenia litura*, F.* Since 1877 this pest has occurred annually more or less numerously upon cotton and other plants, often multiplying in one of its five annual generations to such an extent as to cause great alarm and even serious damage. In view of the recurring nature of the attacks Government Commissions have been appointed at different times during the past 35 years to study means for their prevention, and in 1905 a regularly

* Dudgeon, "The Cotton Worm in Egypt," Bull. Imp. Inst., x, 1912.

organised annual campaign was instituted to carry out a mechanical method of destruction with the assistance of a law. This law compelled cultivators to destroy egg-masses and larvae as soon as they appeared, under penalty of fine or imprisonment.

The cost to the Government for these annual campaigns has varied from £E. 10,000 to £E. 20,000, but this amount represents but a small proportion of the cost to the people themselves. Many other means of destruction have been recommended from time to time, but all have proved more costly, too dangerous to life, or less efficacious than the Government method.

Among the many important matters which required immediate attention when the Agricultural Department of Egypt was organised by myself in 1910, none was more urgent than the control of agricultural pests. The examination of all that had been done in the past shewed that artificial means alone had been relied on for destructive agents, and that no experiments had been conducted to ascertain whether the insect pests were themselves susceptible to any disease. It was obvious that if it were found that they were susceptible, and that such a disease could be easily transmitted and rapidly spread among them, a very great economy could be effected, compared with the cumbrous and very expensive mechanical means which had been hitherto employed.

To this end, in collaboration with Dr. Lewis Gough, Entomologist to the Agricultural Department, bodies carrying diseases known to attack lepidopterous insects, especially silkworms, in different parts of the world, were introduced and the larvae of *Prodenia litura* were infected from them.

Muscardine and other fungoid diseases were found unsuitable owing to the dryness of the climate. Pebrine and flacherie were tried, but the results with these as well as with all others were negatived by the superinfection of a protozoan disease known as "grasserie" (*Miscrosporidium polyedricum*, Bolle) which had been procured in dead bodies of silkworms from Austria. This disease was of such extreme virulence that it pervaded the whole experimental area, destroying all the larvae of *Prodenia* which were being kept for other purposes.

One month after this disease had devastated the experimental laboratory it was found difficult to procure *Prodenia* larvae, from any part of the country, which were not infected by the disease. The attack of cotton worm in this year (1912) was very severe and reached its height by the end of the first week in July, after which it rapidly subsided and by the beginning of August it was almost impossible to obtain any larvae for experimental purposes which had not contracted the disease. There is little doubt that the outbreak in the country was spontaneous and not connected with the introduction which had been made in our laboratories. The spontaneity and virulence of the attack was so remarkable that I was induced to re-examine the imperfect details which had been collected with regard to the cotton worm visitations in previous years. As a result I found that an almost identical condition existed in 1895, which year was followed by two others in which the pest was almost negligible.

The next step was to insure the continuity of the disease. In the spring of the present year, 30,000 silkworms were infected by spraying their food with water in which the macerated remains of one diseased cotton worm had been

mixed. A similar experiment was conducted at the same time, substituting a diseased silkworm instead of the cotton worm. In the latter experiment the silkworms died in rapid succession after the fourth day and none reached maturity. In the experiment where the cotton worm remains had been used as a means of infection only a few worms died on the fourth day, and the incidence of mortality fluctuated considerably for a period of fifteen days or more, but no larva reached the spinning stage.

In the early part of May 1913, cotton worms were unprocurable and by the middle of the month, at which period they are usually numerous, about 80 three-quarter-grown larvae were obtained. These were fed upon leaves sprayed with water containing the macerated body of one diseased silkworm, with the result that on the third day the disease appeared and on the fourth day more than 50 per cent. had succumbed to it. Only about half a dozen survived to pupate and of these none is likely to emerge.

A demonstration in the field of the proper development from these experiments has been hindered by a scanty appearance of the cotton worms themselves ; a result which was anticipated from the severity of the disease in the autumn brood in 1912.

In order to avoid confusion it should be mentioned here that the official method employed in Egypt of computing the virulence of an attack is, although unintentionally so, not only unreliable but often misleading. At the commencement of the season the discovery of two or three leaves bearing egg-masses in a field of 100 acres is sufficient to cause a native official to report that the whole area is infected. It is realised, however, that if more stringent accuracy in estimation were insisted on, the tendency would be to go to the opposite extreme.

One word more in connexion with the application to other countries of the remedy which we are employing in Egypt. Our investigations are as yet insufficiently complete to make it possible to say what influence climatic conditions may have upon the infective power of the disease, but there is no doubt that the artificial dissemination of it by spraying is facilitated in rainless Egypt to a greater extent than would be the case elsewhere. Nevertheless the cheapness and simplicity of the treatment fully merits trials being made upon a much wider scale, the results of which would be of great interest to economic agriculturists throughout the world.

A LIST OF UGANDA COCCIDAE AND THEIR FOOD-PLANTS.

By C. C. Gowdey, B.Sc., F.E.S., F.Z.S.

Government Entomologist, Uganda.

Uganda is a particularly favourable country for the development of insect life, as vegetation grows very luxuriantly and there is no great variation of temperature for any length of time, and insect growth and multiplication are therefore continuous throughout the year. This is especially true with regard to the Coccidae.

This list of Coccidae and their food-plants is the result of an extended search among the flora of Uganda. As these insects are for the most part small and inconspicuous, they have not attracted the amateur collector and hence many of the species here listed proved to be new at the time of their discovery, and these are indicated by an asterisk. Many additional species have been collected, but do not appear in this list as they await identification ; some on account of the paucity of the material and some on account of the adult specimens not having been found.

In order to insure accuracy all identifications of the material collected by the writer were made by Prof. R. Newstead and Mr. E. E. Green, to whom I am much indebted for their kindness in working out the material submitted to them at various times.

The plants on which the Coccidae were found are given a common name only in such cases in which the name is so widely accepted as to preclude the possibility of confusion. In a few instances the botanical names were unobtainable.

Sub-family MONOPHLEBINAE.

Genus Icerya, Sign.

1. *Icerya* sp. No. 4336. On orange.
2. *Icerya caudatum*, Newst.* On crotons.
3. *Icerya seychellarum*, Westw. On *Monodora myristica* and *Eranthemum bicolor*.

Sub-family DACTYLOPIINAE.

Genus Dactylopius, Costa.

4. *Dactylopius* sp. nov., Newst. No. 1433. On unknown shrub.
5. *Dactylopius* (*Pseudococcus*) *citri*, Risso. On coffee, orange and lemon, and on an unknown shrub in the depth of the Tero Forest.

Sub-family TACHARDIINAE.

Genus Tachardia, Blanch.

6. *Tachardia decorella*, Mask. On *Anona muricata*.
7. *Tachardia longisetosa*, Newst.* On *Ficus sycamorus* (bark-cloth tree) ; also found by the author at Bukoba, German East Africa.

Sub-family COCCINAE.

Genus PULVINARIA, Targ.

8. *Pulvinaria* sp. nov., Newst. On *Tecoma stans*.

9. *Pulvinaria jacksoni*, Newst. On cotton. Parasitised by *Tetrastichus gowdeyi*, Crawf.

10. *Pulvinaria psidii*, Mask. On coffee, *Funtumia elastica*, guava, tea, *Alternanthera versicolor* and *Markhamia platycalyx* (Nsambyia).

Genus CEROPLASTES, Gray.

11. *Ceroplastes* sp. No. 1274. On guava; also found by the author at Bukoba.

12. *Ceroplastes* sp. nov., Newst. No. 1326. On bark-cloth tree; also found at Bukoba.

13. *Ceroplastes* sp. nov., Newst. On bark-cloth tree.

14. *Ceroplastes africanus*, Green. On *Acacia* sp. and *Cajanus indicus*.

15. *Ceroplastes ceriferus*, And. On *Antignon leptopus*, orange, coffee, *Funtumia latifolia*, tea, Canna, croton, Agave, Hibiscus and bark-cloth tree.

16. *Ceroplastes coniformis*, Newst.* On *Ficus* sp.

17. *Ceroplastes destructor*, Newst.* On guava.

18. *Ceroplastes ficus*, Newst.* On bark-cloth tree; also found by the author at Bukoba, German East Africa.

19. *Ceroplastes galeatus*, Newst.* On coffee and bark-cloth tree.

20. *Ceroplastes quadrilineatus*, Newst.* On *Anona muricata* and Nsambyia.

21. *Ceroplastes singularis*, Newst.* On guava.

22. *Ceroplastes ugandae*, Newst.* On *Acacia* sp. and *Anona muricata*.

23. *Ceroplastes vinsonioides*, Newst.* On *Baikea eminii*, coffee and guava.

Genus INGLISIA, Mask.

24. *Inglisia conchiformis*, Newst.* On *Anona muricata* and *Harrogania madagascariensis*. Parasitised by *Eublemma scitula*, Ramb.

Genus CEROPLASTODES, Ckll.

25. *Ceroplastodes gowdeyi*, Newst.* On bark-cloth tree.

Sub-family LECANIINAE.

Genus LECANIUM, Burm.

26. *Lecanium africanum*, Newst. On coffee.

27. *Lecanium elongatum*, Sign. On *Albizzia* sp. and *Cajanus indicus*.

28. *Lecanium* (*Eulecanium*) *filamentosum*, Newst.* On an unknown forest shrub.

29. *Lecanium* (*Eulecanium*) *somereni*, Newst. On mulberry, *Tecoma stans* and *Markumia platycalyx*.

30. *Lecanium* (*Coccus*) *hesperidum*, L. On orange.

31. *Lecanium (Saissetia) nigrum*, Nietner. On *Ficus* sp. and *Anona muricata.*

32. *Lecanium (Saissetia) oleae*, Bern. On *Chlorophora excelsa.*

33. *Lecanium tenuivalvatum*, Newst.* On elephant grass and lemon grass.

34. *Lecanium viride*, Green. On coffee and guava. Preyed on by *Chilocorus discoideus* and *C. punctata.*

Genus Stictococcus, Ckll.

35. *Stictococcus dimorphus*, Newst.* On *Cajanus indicus*, cacao, *Croton tiglium*, *Anona muricata*, *Markhamia platycalyx* and mulberry. Parasitised by *Eublemma costimacula*, Saalm.

36. *Stictococcus gowdeyi*, Newst.* On *Harrogania madagascariensis* and coffee.

Sub-family DIASPINAE.

Genus Chionaspis, Sign.

37. *Chionaspis cassiae*, Newst.* On *Cassia floribunda.*

38. *Chionaspis dentilobis*, Newst.* On palms and *Sapium mannianum.*

39. *Chionaspis substriata*, Newst.* On palms.

Genus Diaspis, Costa.

40. *Diaspis (Aulacaspis) chionaspis*, Green.* On *Sapium mannianum* and *Cassia floribunda.*

41. *Diaspis regularis*, Newst.* On *Chlorophora excelsa.*

Genus Aspidiotus, Bouché.

42. *Aspidiotus cyanophylli*, Sign. On guava, palms.

43. *Aspidiotus cydoniae*, Comst. On guava.

44. *Aspidiotus gowdeyi*, Newst.* On *Anona muricata.*

45. *Aspidiotus transparens*, Green. On tea.

46. *Aspidiotus trilobiformis*, Green. On oleander.

Genus Lepidosaphes, Schimer.

47. *Lepidosaphes beckii*, Newm. (*citricola*, Pack.). On orange, lemon.

Genus Ischnaspis, Dougl.

48. *Ischnaspis filiformis*, Dougl. On palms and bamboo.

Genus Gymnaspis.

49. *Gymnaspis africana*, Newst.* On an unknown forest shrub.

COLLECTIONS RECEIVED.

The thanks of the Imperial Bureau of Entomology are due to the following gentlemen, who have kindly presented collections of insects (received between 1st April and 30th June, 1913):—

Dr. W. M. Aders:—18 Culicidae, 3 *Haematopota*, 119 *Tabanus*, 4 other Diptera, 3 Hymenoptera, 21 Coleoptera, 4 Lepidoptera, a number of Coccidae, and 3 other Rhynchota; from Zanzibar.

Mr. E. Ballard, Government Entomologist:—2 Simuliidae, 5 other Diptera, 14 Hymenoptera, 34 Coleoptera, 20 Lepidoptera, 10 Orthoptera, and 12 Rhynchota; from Nyasaland.

Mr. G. E. Bodkin, Government Economic Biologist:—6 *Chrysops*, 1 *Tabanus*, 9 other Diptera, 56 Hymenoptera, 62 Coleoptera, 2 Planipennia, 32 Rhynchota, and 4 Orthoptera; from British Guiana.

Captain St. G. Booth:—38 Culicidae; from Ngabotok, British East Africa.

Dr. G. D. H. Carpenter, Entomologist, Royal Society's Sleeping Sickness Commission:—26 Hymenoptera, 90 Coleoptera, 1 Lepidopterous larva, 12 Rhynchota, 4 Arachnida, 40 Argulidae, and a tube of Worms; from Damba Island, Uganda.

Dr. J. M. Dalziel, M.O.:—11 Culicidae, 7 *Tabanus*, 24 other Diptera, 6 Coleoptera, 4 Rhynchota, and 5 Orthoptera; from Northern Nigeria.

Dr. J. R. Dickson, Assistant Medical Officer of Health:—Eggs and larvae of Culicid (*Megarhinus trinidadensis*); from Trinidad, B.W.I.

Dr. R. E. Drake-Brockman:—9 *Haematopota coronata*, 1 *Tabanus morsitans*, 1 *Stygeromyia maculosa*, 4 Coleoptera, 1 Chrysidid, and 33 Ticks (*Ornithodorus savignyi*); from British Somaliland.

Dr. A. G. Eldred, M.O.:—44 Culicidae, 2 *Chrysops*, 1 *Haematopota alluaudi*, 2 *Tabanus*, 1 *Glossina brevipalpis*, 2 *Stomoxys*, 5 other Diptera, and 1 Bug; from Nyasaland.

Mr. T. E. Fell, Provincial Commissioner:—1 *Tabanus argenteus*; from Ashanti.

Rev. W. B. Gill:—8 Diptera, 8 Hymenoptera, 25 Coleoptera, 16 Lepidoptera, 11 Rhynchota, 3 Orthoptera, and 1 Tick; from Uganda.

Mr. H. Glasgow, Department of Entomology, University of Illinois:—A collection of North American *Anopheles* Mosquitos, *Ceratophyllus* Fleas, *Laelaps* Mites, and *Amblyomma*, *Dermacentor*, and *Haemaphysalis* Ticks.

Dr. Lewis H. Gough, Government Entomologist:—A tube of Aphididae; from Egypt.

Mr. C. C. Gowdey, Government Entomologist:—1 Culicid, 1 *Chrysops*, 1 *Haematopota*, 1 *Hippocentrum*, 28 *Tabanus*, 183 other Diptera, 566 Hymenoptera, 680 Coleoptera, 12 Lepidoptera, a number of Coccidae, 447 other Rhynchota, 410 Orthoptera, and 10 Ticks; from Uganda.

Mr. J. A. Ley Greaves, Resident; 39 *Glossina*; from Northern Nigeria.

Capt. Hutchinson:—3 *Haematopota*, 1 *Tabanus* par, 3 *Glossina palpalis*, and 1 *Sarcophaga*; from Uganda.

Imperial Department of Agriculture, West Indies:—7 Aphididae and 419 Termites; from the West Indies.

Major H. Kelsall:—20 tubes of feather parasites, and 11 tubes of intestinal worms from snakes, &c.; from Sierra Leone.

Mr. W. Kennedy, Veterinary Officer:—15 *Haematopota*, 27 *Stomoxys*, 1 *Bdellolarynx* sp. nov., and 24 *Hippobosca*; from British East Africa.

Mr. Chas. H. Knowles, Superintendent of Agriculture:—2 Chalcidids; from Fiji.

Mr. F. A. Knowles, Provincial Commissioner:—369 Ticks; from Uganda.

Capt. A. O. Luckman, Assistant District Commissioner:—3 Culicidae, 2 other Diptera, 9 Hymenoptera, 27 Coleoptera, 9 Lepidopterous larvae, 5 Orthoptera, 1 Millipede, 3 Arachnida, and 4 Snakes; from the Masai Reserve, British East Africa.

Dr. A. D. Milne, Principal Medical Officer:—10 Culicidae, 21 *Haematopota hirta*, 72 other Diptera, 175 Hymenoptera, 688 Coleoptera, 650 Butterflies, 77 Moths, 1 Lepidopterous larva, 3 Odonata, 824 Rhynchota, 3 Orthoptera, and 1 Spider; from British East Africa.

Dr. J. G. Morgan, M.O.:—7 Culicidae, 28 *Haematopota*, 1 *Chrysops wellmani*, 15 *Tabanus*, 4 *Auchmeromyia luteola*, 26 other Diptera, 10 Dipterous larvae, 38 Siphonaptera, 117 Cimicidae, 33 Anoplura, and 79 Ticks; from Nyasaland.

Mr. S. A. Neave:—61 Culicidae, 15 Culicid larvae, 2 Culicid pupae, 149 *Chrysops*, 115 *Haematopota*, 20 *Tabanus*, 32 *Glossina*, 43 *Stomoxys*, 1,166 Asilids with prey, 36 pairs of Asilids (taken in cop.), 309 other Diptera, 3 Dipterous pupa cases, 1,770 Hymenoptera, 8 Hymenoptera with prey, 6 Hymenopterous pupae, 7 Hymenopterous pupa cases, 10,822 Coleoptera, 1,416 Butterflies, 3,544 Moths, 14 Lepidopterous pupa cases, 5 Trichoptera, 19 Planipennia, 1 Cimicid, 953 other Rhynchota, 98 Siphonaptera, 3 Odonata with prey, 205 Orthoptera, 44 Ticks, and 27 Mites; from Mlanje, Nyasaland.

Dr. P. D. Oakley, M.O.:—32 *Glossina*; from the Northern Territories, Gold Coast.

Dr. J. E. S. Old, M.O.:—A box of Culicidae, destroyed in transit.

Mr. A. D. Peacock, late Government Entomologist:—2 *Tabanus*, 28 other Diptera, 67 Hymenoptera, 126 Coleoptera, 5 Odonata, 78 Rhynchota, and 14 Orthoptera; from Southern Nigeria.

Dr. Samuel Shepheard:—14 Tabanidae; from Colombia, South America.

Dr. Jas. J. Simpson:—1 Culicid, 1 *Haematopota*, 412 *Tabanus*, 662 *Glossina*, 2 *Stomoxys*, 127 Hippoboscidae, 4 Hippoboscid pupae, 28 other Diptera, a number of Oestrid larvae, 233 Hymenoptera,

32 Coleoptera, 30 Lepidoptera, 4 Planipennia, 49 Odonata, 1 Cimicid, 3 other Rhynchota, 215 Orthoptera, 173 Ticks, and 16 Arachnida; from the Gold Coast Colony.

Dr. B. Spearman, M.O.:—10 *Tabanus* and 5 *Glossina*; from Uganda.

Dr. H. S. Stannus, M.O.:—28 *Ceratopogon*, 1 *Culicoides*, 74 Culicidae, 1 *Chrysops wellmani*, 36 *Haematopota*, 17 *Tabanus*, 2 Glossina, 103 other Diptera, 4 Hymenoptera, 24 Coleopteoa, 11 Lepidoptera, 11 Rhynchota, 1 Tick, and 1 Spider; from Nyasaland.

Mr. F. W. Urich, Entomologist to the Board of Agriculture:—118 Scolytid Beetles, 2 Dynastid Beetles, and Nematodes from *Tomaspis saccharina*; from Trinidad, B.W.I.

Dr. R. van Someren, M.O.:—A box of Coccidae; from Uganda.

Dr. J. Y. Wood, M.O.:—15 Culicidae, 10 Simuliidae, 8 *Haematopota*, 18 *Tabanus*, 1 *Rhinomyza*, 109 *Glossina*, and 2 other Diptera; from Sierra Leone.

Mr. R. C. Wroughton:—1 *Chrysops*, 2 *Haematopota*, . *Auchmeromyia*, and 253 other Diptera; from Natal, S. Africa.

ON THE ORIENTAL CULICID GENUS LEICESTERIA, THEOBALD.

By F. W. Edwards, B.A., F.E.S.

(*Published by permission of the Trustees of the British Museum.*)

The genus *Leicesteria* was founded by Theobald in 1904 (Entomologist, xxxvii, p. 211) for a species of mosquito found by Dr. G. F. Leicester in the Malay States, the most remarkable character of which was the great length of the female palpi, a condition known otherwise among the Culicidae only in *Anopheles*, *Megarhinus* and *Mucidus*, all genera to which the new species was obviously unrelated. Subsequently Dr. Leicester* placed on record his discovery of four other species essentially similar to Theobald's *Leicesteria longipalpis*; for one of these he created the new genus *Chaetomyia*. Additional species referable to the genus have since been described by Theobald.†

The present contribution is based mainly on an examination of Dr. Leicester's fine collection, which he has recently presented to the British Museum; a study of this has revealed the existence of three undescribed species, descriptions of which are herewith presented. Through the courtesy of Dr. N. Annandale and Mr. F. H. Gravely of the Indian Museum I have also been enabled to make a detailed examination of the types of *Leicesteria apicalis*, Theo., and *Brevirhynchus apicalis*, Theo.; I am therefore in a position to offer a thorough revision of the species of this interesting genus. The very clear drawings of male genitalia have been made for me by my wife from balsam preparations. It should be noted that the basal parts are represented as transparent in order to show the unci.

Characters and systematic position of the genus.

Adult characters.—Eyes very narrowly separated. Proboscis thick, shorter than the abdomen, very slightly swollen at the apex. Male antennae plumose. Palpi of female at least half as long as the proboscis, three-jointed, the elongation occurring mainly in the second joint, terminal joint minute; palpi of male longer than the proboscis by the last joint, thin, without hair-tufts, the last two joints curved upwards. Prothoracic lobes well separated, and more or less retracted under the mesonotum which is arched forwards over the head. Scutellum obviously trilobed. Postnotum‡ without setae (except in *L. flava*). Front

---

* Studies from Inst. for Med. Research, Fed. Malay States, iii, pt. 3, pp. 94–100 (1908).

† Rec. Ind. Mus. ii, 1908, pp. 291–294

‡ Following Dyar and Knab, the writer replaces the term "metanotum" by "postnotum," since the structure indicated is really part of the mesothorax and not of the metathorax.

(32926—2.) Wt. P 12—42. 1000. 2/14. D & S. A

tibiae shorter than the others (except in *L. flava*, in which the hind pair are the shortest). Hind tibiae provided with a distinct scraper at the tip. Front claws of male unequal, one or both toothed; middle claws equal or almost so, toothed; front and middle claws of female equal, toothed. Wings of the normal Culicid type, without any distinctive feature. Male genitalia: the side-pieces have well-developed basal lobes, which bear spines, but the lobes are not sufficiently divided off from the side-pieces to be regarded as true harpagones; clasp-filament with 5–9 apical or subapical spines; unci with slightly crenulate margins. Female abdomen tapering; eighth segment very large and not at all retractile. Head, and scutellum clothed with broad flat scales. Except in the doubtful *L. annulipalpis*, the colouring is of uniform type throughout the genus. The covering of the thorax is brown, narrowly creamy on the borders; the abdominal scaling is brown above, with large white lateral patches on each tergite.

Larval characters.—Nothing has been recorded concerning the larvae, beyond the fact that they live in bamboos. I have so far been unable to obtain any specimens through correspondents for purposes of description.

Systematic position.—The genus doubtless belongs to the *Aëdes* group of the CULICINI, in spite of the fact that one of the species, in having short hind tibiae and setae on the postnotum, exhibits two otherwise exclusively Sabethine characters. This species (*L. flava*), however, cannot be separated from the genus, as in all other respects, especially in its male genitalia, it conforms to the generic characters of *Leicesteria*; its Sabethine characters should probably, therefore, be regarded as evidence of reversion to an earlier type. The nearest relative of *Leicesteria* is evidently *Armigeres* (= *Desvoidya*), which differs only as follows: the female palpi are much shorter; the mesonotum is not distinctly produced over the head; the male genitalia have much more numerous spines on the clasp-filament, and the basal lobes of the side pieces are not so well developed. The two genera together form a distinct division of the *Aëdes* group, distinguished by the peculiar structure of the male genitalia and (probably) by the structure and habits of the larvae, those of *Armigeres* being carnivorous and having neither hair-tuft nor pecten on the siphon-tube. Whether the two genera will ultimately have to be united cannot at present be decided.

The following synonymy may be given for the genus:

LEICESTERIA, Theo.

Entomologist, xxxvii, p. 211 (1904).

Chaetomyia, Leic., Cul. of Malaya, p. 100 (1908).

Brevirhynchus, Theo., Rec. Ind. Mus. ii, p. 293 (1908).

Leicesteriomyia, Brun., Rec. Ind. Mus. iv, p. 452 (1912) (nom. n. for *Chaetomyia*).

Brevirhynchus is in all respects similar to *Leicesteria*; Theobald had apparently forgotten the existence of the latter genus when redescribing it under a new name.

Key for determining the Species.

1. Female with simple claws; the palpi with a white ring in the middle; all joints of hind tarsi with distinct basal white rings ... *annulipalpis*, Theo.
   Female with toothed claws on the front and middle legs; female palpi without white ring in middle; if the hind tarsi have pale rings these generally embrace both ends of the joints ... ... 2.
2. Hind tibiae distinctly shorter than the front ones; postnotum with a few setae or scales or both ... ... *flava*, Leic.
   Hind tibiae slightly longer than the front ones; postnotum bare 3.
3. Abdominal segments 4–7 with basal lateral yellow patches, in addition to the more apically placed white ones; hind tarsi with more or less distinct pale rings ... ... 4.
   Abdominal segments 4–7 without lateral yellow patches; hind tarsi and palpi entirely dark ... ... 6.
4. Clypeus bare; female palpi all dark; thorax much produced over the head ... ... *dolichocephala*, Leic.
   Clypeus more or less scaly; female palpi with the extreme tip white; thorax not so much produced ... ... 5.
5. Yellowish median basal patches on abdominal segments 3–8 or 5–8; the white lateral patches on segments 6 and 7 not quite reaching the hind margins... ... ... *magna*, Theo.
   No yellowish median basal patches on abdominal segments; the white lateral patches on segments 6 and 7 reaching the hind margins ... ... *annulitarsis*, Leic.
6. White lateral abdominal patches produced over the dorsum at or near the apices of the segments ... ... 7.
   White patches not at all produced over the dorsum, which is all blackish ... ... 8.
7. The lateral abdominal patches become creamy towards the dorsum, where they form narrow but complete apical bands *cingulata*, Leic.
   The lateral abdominal patches do not become creamy dorsally, do not quite meet in the middle line, and do not quite reach the hind margins ... ... *longipalpis*, Leic.
8. White lateral abdominal patches with their upper edges straight; hind metatarsi distinctly shorter than the tibiae *pendula*, sp. n.
   White patches with their upper edges markedly concave; hind metatarsi and tibiae about equal in length ... ... 9.
9. Smaller; female palpi two-thirds as long as the proboscis *digitata*, sp. n.
   Larger; female palpi only half as long as the proboscis *pectinata*, sp. n.

1. **L. annulipalpis** (Theo.).

Brevirhynchus annulipalpis, Theo., Rec. Ind. Mus. iv, p. 6 (1910).

I have not examined the type of this species, and feel some doubt whether it really belongs here, as the type of marking appears to be quite different from

that of all the other species, besides which the claws are said to be all simple. Until the male is known however it can only be placed in this genus.

Described by Theobald from a single female from Travancore (Maddathoray).

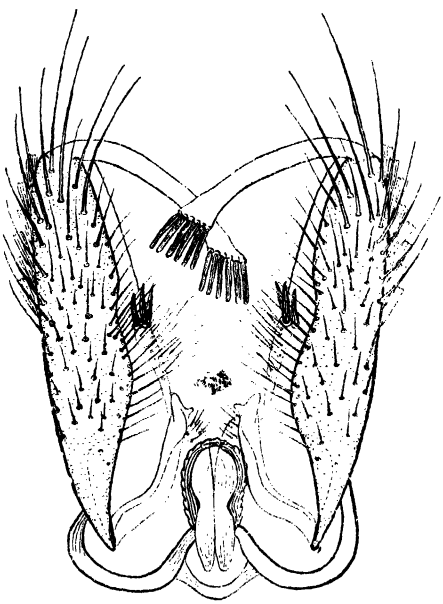


Fig. 1.—Male genitalia of *Leicesteria flava*, Leic.

2. **L. flava** (Leic.).

Chaetomyia flava, Leic., Stud. Inst. Med. Res., Fed. Malay States, iii, p. 101 (1908).

Leicesteria apicalis, Theo., Rec. Ind. Mus. ii, p. 291 (1908).

Brevirhynchus apicalis, Theo., Rec. Ind. Mus. iv, p. 7 (1910).

I have compared the male and female types of *Leicesteria apicalis* with the female type of *Brevirhynchus apicalis* and with three female cotypes of *Chaetomyia flava*; they undoubtedly all belong to the same species, and it is somewhat curious that Theobald should have redescribed *L. apicalis* under the same specific name although it is of course no occasion for surprise that he made no reference to his former description. The postnotum in each of these specimens bears at least two or three small pale hairs, while Leicester's specimens have some scales in addition. *L. apicalis* ♀ was described as having the integument of the thorax "shiny black"; this is quite incorrect, it is rather light brown (even in the type) as in other species of the genus. The middle legs of the male type are missing, hence probably Theobald's statement that the middle claws are unequal was pure assumption; they are equal in the Sarawak male as in all the other species I have examined. I made a preparation of the genitalia of the male type of *L. apicalis* and found that they corresponded in almost every detail with those of the specimen figured (from Sarawak); there were however five instead of six apical spines to the claspers. In both the males examined the basal lobes of the side-pieces bore three spines.

Apart from the tibial characters, *L. flava* much resembles *L. cingulata*, from which it can easily be distinguished by the narrow pale rings on the tarsi and the yellowish rings on the male palpi.

Malay States ; Assam ; Sarawak (*J. Hewitt*, 1 ♂ 1 ♀ in Cambridge Museum).

3. **L. dolichocephala**, Leic.

Leicesteria dolichocephala, Leic., *op. cit.* p. 95.

It is a little difficult to be certain whether the hood-like appearance of the thorax is entirely natural, or whether it may not be partly due to the head having shrunk. The pale rings on the hind tarsi are much fainter than in the two following species and may be quite absent ; the dorsum of the abdomen, as in *L. annulitarsis*, is entirely dark, except for a yellowish patch on the eighth segment ; the white patch on the second abdominal segment is more oblique than in the next two species. The British Museum possesses four female cotypes ; I have not seen a male.

Recorded only from near Kuala Lumpur, Federated Malay States.

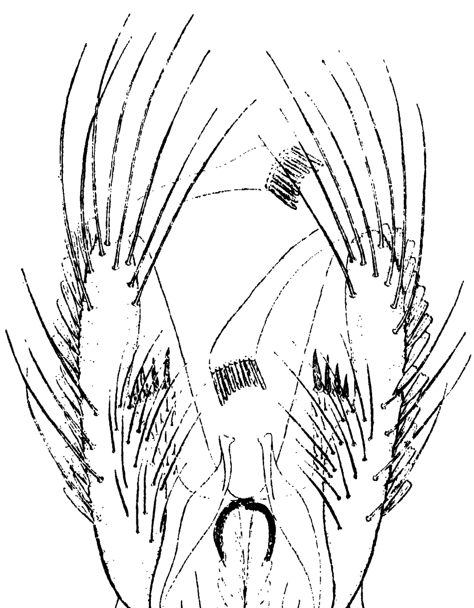


Fig. 2.—Male genitalia of *Leicesteria magna*, Theo.

4. **L. magna** (Theo.).

Brevirhynchus magnus, Theo., Rec. Ind. Mus. ii, p. 293 (1908).

Leicesteria annulitarsis (♂ only), Leic., *op cit.* p. 100 (1908).

Toxorhynchites rectirostris (Giles MS.), Theo., Mon. Cul. v, p. 214 (1910) (*nom. nud.*).

The characters given in the key should facilitate the recognition of this species. It is rather larger than *L. annulitarsis* and the tips of the female palpi are not so

conspicuously white. The male genital claspers terminate in a comb consisting of nine blunt-ended teeth and the basal lobes of the side-pieces bear four teeth in a single row.

Dr. Leicester had apparently not distinguished this species from the next.

Assam; Travancore; Sukna; Philippine Islands (1 ♀, *Lt. E. R. Whitmore*, presented to the British Museum by Col. Giles); Federated Malay States: Ulu Klang and near Kuala Lumpur (1 ♂ 2 ♀ in British Museum in Dr. Leicester's collection).

5. **L. annulitarsis,** Leic.

Leicesteria annulitarsis, Leic., *op. cit.* p. 99.

Apart from the characters already noticed, this species seems to differ from *L. magna* in the possession of long lateral scales on the *whole* of the second vein; in the latter species the base of this vein appears to be without lateral scales, but this may possibly be due to denudation. There are four females in the British Museum in Dr. Leicester's collection, but the male is at present unknown, Leicester's single male really being the male of *L. magna*.

Recorded only from the Kuala Lumpur district.

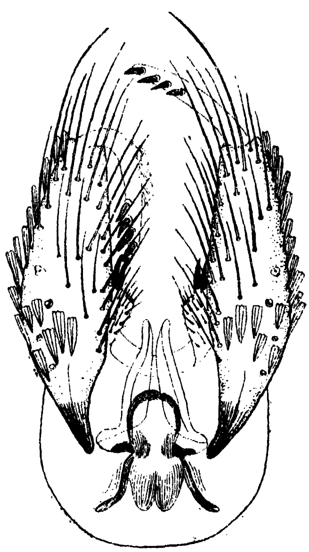


Fig. 3.—Male genitalia of *Leicesteria cingulata*, Leic.

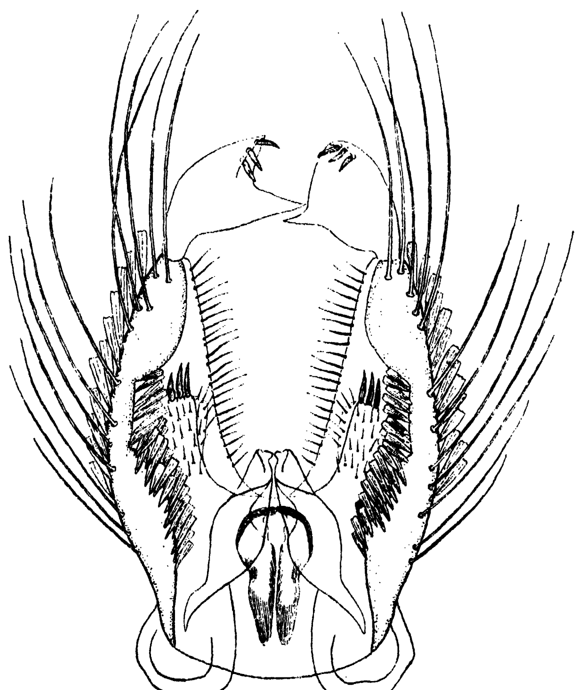


Fig. 4.—Male genitalia of *Leicesteria longipalpis*, Leic.

6. **L. cingulata,** Leic.

Leicesteria cingulata, Leic., *op. cit.* p. 97.

The three specimens (1 ♂ 2 ♀) in the British Museum have no scales on the clypeus; they are labelled "The Gap. At the edges of a stream in the jungle.

16.iv.04." The basal lobes of the male genitalia bear two teeth; the claspers have four teeth placed rather far apart, and also on the opposite side a row of scales.

Recorded only from the Kuala Lumpur district.

7. **L. longipalpis,** Leic.

Leicesteria longipalpis, Leic., Entomologist, xxxvi, p. 211 (1904).

This species is represented in the British Museum by the type male (from which the accompanying drawing was taken), the type female and one other female. The male genital claspers are much broader than in any other species and, in addition to the three chitinous teeth, are provided with a large membranous projection: the basal lobes of the side-pieces bear three teeth and the side-pieces themselves have a large patch of scales which seem to project inwards.

Known definitely only from the Kuala Lumpur district.

8. **L. pendula,** sp. n. ♂.

Head clothed mainly with blackish flat scales; a narrow border of creamy ones round the eyes, large lateral creamy patches, and a small patch in the middle also creamy. Clypeus bare. *Thorax* coloured much as in the other

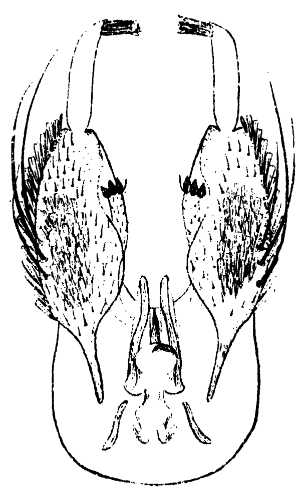


Fig. 5.—Male genitalia of *Leicesteria pendula*, Edw.

members of the genus: integument reddish brown; mesonotum clothed with dark brown narrow scales, with a narrow border of creamy ones; scales on pleurae and prothoracic lobes whitish, those on scutellum dark brown. *Legs* with scales all dark brown, except those on the undersides of the femora, which are whitish. Front tibiae markedly shorter than the middle and hind ones; all the tibiae noticeably longer than the corresponding metatarsi; the last three joints of the middle tarsi are (in the dried specimens) bent backwards. Front claws very unequal; the larger one with a single tooth near the base, the smaller simple. Middle claws equal, rather small, each with a slight thickening

near the base which cannot be called a tooth. Hind claws very small, equal and simple, nearly straight. *Wings* shorter than in any of the other species; if extended backwards they only reach to the base of the sixth abdominal segment. First fork-cell longer than second, their bases almost level. *Abdomen* dark brown: first segment with a white lateral patch; second to seventh with large white lateral triangular patches, their apices not quite reaching the apices of the segments; as in the other species these patches are diagonally placed. *Genitalia* very small, completely exserted and pendulous (whence the specific name). Claspers with five teeth arranged in a bunch at the apex. Side-pieces with a large scale patch on the ventral side; their basal lobes bear three teeth and also a fine hair. The genitalia are much less hairy than in the other species.

Length of body (without head) 6 mm.; of wing 4 mm.

Described from a type male and three other males in Dr. Leicester's collection in the British Museum, labelled "Edges of stream in jungle. The Gap. 16. iv. 04." (*Dr. G. F. Leicester.*)

9. L. digitata, sp. n. ♂ ♀.

Differs from *L. pendula* as follows: White patches of abdomen less pointed, and with their upper or anterior edge somewhat concave, especially in the female. Hind metatarsi of the male almost as long as the tibiae. Middle claws of the male each with a small but distinct tooth. Wings a trifle longer than in *L. pendula*, those of male reaching to the apex of the 6th abdominal segment. Genitalia not quite completely exserted, not at all pendulous and much more

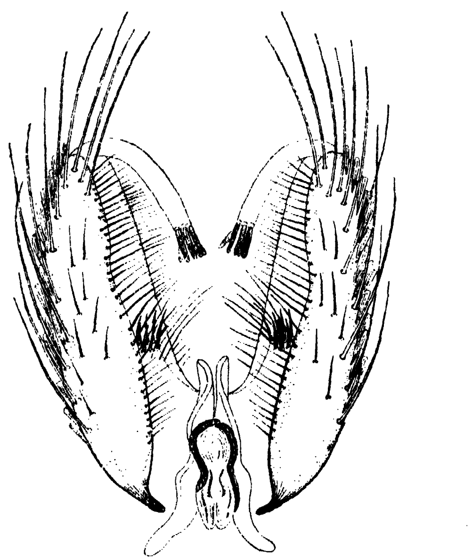


Fig. 6.—Male genitalia of *Leicesteria digitata*, Edw.

bristly. The claspers bear five terminal spines which are less pointed than in *L. pendula* and are arranged something like the spread-out fingers of a hand. The basal lobes of the side-pieces have seven sharp spines which, when seen from certain directions, appear to be arranged in two rows. Female palpi quite two-thirds as long as the proboscis.

Length of body (without head) about 4 mm.

The following specimens are in the British Museum: Type and one other male and one female, bred from larvae in bamboo, Ulu Gombak, Federated Malay States, 28. viii. 03 and 2. ix. 03 (*Dr. C. W. Daniels*); 2 ♀, at edges of stream in jungle, The Gap, 16. iv. 04 (*Dr. G. F. Leicester*); 1 ♂ 1 ♀, Pahang Road jungle, 6 miles from Kuala Lumpur, 4. iv. 03 and 18. x. 03 (*Dr. G. F. Leicester*); 1 ♂ 2 ♀, Mailum Negros, Philippine Islands, 9. vi. 06 (*C. S. Banks*; identified by the collector as *L. longipalpis*).

10. **L. pectinata**, sp. n. ♂ ♀.

Differs from *L. digitata* only as follows: Rather larger (5 mm.); female palpi shorter, scarcely more than half the length of the proboscis. Male genitalia: the claspers terminate in a comb-like row of nine teeth; the basal lobes of the side pieces each carry two separate pairs of teeth.

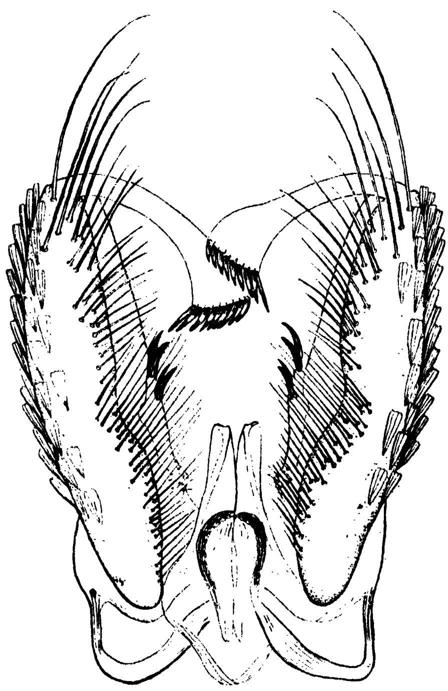


Fig. 7.—Male genitalia of *Leicesteria pectinata*, Edw.

Type male and one female bred from larvae (?) in leaf in jungle, 3–7. ix. 04, at Jugra, Federated Malay States (*Dr. G. F. Leicester*). A second male (the one figured) is unlabelled, but looks as though it may have belonged to the same lot. There is a female in the Cambridge Museum from Sarawak (*J. Hewitt*).

DISEASE-BEARING INSECTS IN SAMOA.

By R. W. Doane.

Stanford University, California.

(Plates XXIX-XXXI.)

A short stay on the island of Upolu, German Samoa, during the summer of 1913, afforded an opportunity to make a few observations on mosquitos and flies, which I wish to record. As practically all my time was taken up with another problem, only fragmentary notes could be made on these insects.

As in many of the Pacific Islands, *Stegomyia fasciata*, *S. pseudoscutellaris* and *Culex fatigans* vie with each other for supremacy in point of numbers and in the amount of irritation they can cause the inhabitants. As soon as the visitor reaches his room at his hotel he finds *S. fasciata* there to greet him, and from morning until night her attentions are untiring as long as he is around the house, particularly if he sits down to read or to do a piece of work in his laboratory. A siesta is out of the question without the protection of a mosquito net.

The natives pay but little attention to this mosquito, seeming to take it as one of the necessary things of life, and most of the white residents soon assume much the same attitude toward the pest. But the newcomer is often annoyed almost beyond endurance, and usually makes some effort to combat the tormentor. He soon finds, however, that this insignificant-looking little black mosquito is not like the mosquitos with which he is familiar in colder climes, for it approaches quietly from the rear or on the shady side and sings its high-pitched song of triumph after, and not before, it has feasted. It has a wonderful faculty for finding the thin spots in one's clothes, and delights to feed on your ankles as you sit with your feet under the table or desk. Its long association with man has made it wondrous wise.

After trying many things we found that most relief could be had by simply taking time to go after and capture the mosquitos in the room with an insect net. The few stragglers that escape in the first round-up, or that come into the room later, can be captured one at a time, if the insect net is close at hand while one is at work.

On account of the frequent and heavy rains and because of the lack of any sewage system, there are always plenty of places for the mosquitos to breed around the houses, and as a rule little or no attempt is made to control the number of mosquitos by limiting the number of breeding places. Spasmodic or half-hearted control measures will do but little good. In a house that was 300 feet or more from its nearest neighbour all the cisterns were covered with double screens and the tin cans and broken bottles in the immediate vicinity of the house were emptied ; but no relief was obtained. Climbing to the roof of the house I found that one of the eaves-troughs had sagged somewhat just over my laboratory window and in the little water that had collected there the mosquitos were breeding abundantly (Plate XXIX). As the adults issued they could easily pour through the open window into the house, for no door- or window-screens are used

in Samoa. Further search showed that the borders of a walk and the top of a retaining wall had been decorated by burying beer bottles in the ground and in the cement, respectively, leaving only an inch or two of the concave bottom exposed. These had become so overgrown with vines and weeds that they were hidden, but when they were exposed the upturned bottom of each bottle was found to contain a little water, only a little, but all that was necessary for the mosquitos to breed in. More bottles, broken and unbroken, empty tin cans, and broken coconut shells were found on the hillside below the house. Many of these contained larvae and pupae of this and other species of mosquitos. An old breadfruit tree just behind the house branched close to the ground. In the crook thus formed was a hole about six inches deep, ten inches long and six inches wide, that was filled with water swarming with mosquito larvae and pupae (Plate XXX). I record these things in detail because they are typical conditions, and show something of the things that will have to be contended with if it should ever become necessary to adopt control measures for this mosquito. As yet, no yellow fever germs have reached the South Pacific Islands, but all who are familiar with the conditions there know how much greater the danger will be after the Panama Canal is open and more direct communication is established with regions where yellow fever is endemic. One infected mosquito would be enough to start an epidemic there. There is no law requiring that deaths be reported, so that the disease might gain considerable headway, and great numbers of mosquitos become infected, before the authorities were aware that the disease was on the island.

As twilight comes these mosquitos begin to seek places where they may quietly spend the night and be ready to begin work again with the first grey light of morning. But *S. fasciata* does not retire until the brown night mosquito *C. fatigans* is ready to take up the night shift. This mosquito, too, is stealthy in its habits, but a low irritating buzz usually warns the intended victim that danger is near. The Samoans make a little more effort to protect themselves from this species, for they realise, in some measure, the danger that may attend its bite. Physicians in these islands believe that more than 50 per cent. of the Samoans become infected with *Filaria bancroftii* by being bitten by this mosquito. They do not all suffer from this infection, but so long as the parasite is in the blood there is always danger of its causing trouble some time. The many swollen legs or arms or other parts of the body show the terrible conditions for which these little parasites may be responsible. Until one has seen a few bad cases of elephantiasis, one can hardly realise that parts of the body could assume such monstrous proportions. Until recently there has been little or no relief from the disease, but surgical operations now often give complete or great alleviation.

White men become infected with these filaria as readily as do the natives, and few who live there more than a few months escape one or more attacks of "moo-moo," as the early stage of the disease is called. The fever, and often the chills, that come with these first attacks may last for only a few days, and usually yield quite readily to treatment. But later attacks become more prolonged and obstinate, and the patient must then go to a colder country if he wishes to escape the final results of the disease, elephantiasis.

Besides carrying the filaria that is responsible for so much trouble, *Culex fatigans* also transmits the organism that produces dengue fever, a disease that causes an endless amount of suffering among the Samoans and frequently among white men also. That the fever is caused by the presence of some minute organism, probably in the blood of the patient, there seems to be little doubt. Just what the organism is has not yet been demonstrated. Dr. J. C. Parham, Asst. Surgeon, United States Navy, has been studying the disease in Pago Pago and believes that a certain coccus-like protozoan that he has found in the blood of many patients is the causative agent, but his investigations have not yet been completed. Of the life-history of the parasite in the mosquito little is known, but it seems that a period of a little more than three days must elapse after a mosquito has bitten a patient suffering with the fever, before it becomes infective.

Unusual exposure to cold or wet weather or a weakening of the body from any other cause is often followed by an attack of dengue. Recently all of the Samoans were vaccinated against small-pox and many of those who suffered most from the effect of the vaccination had to endure the tortures of dengue at the same time.

Culex fatigans is usually found breeding with *S. fasciata* near dwellings, but it may be found much further away in the field or bush, breeding with *S. pseudoscutellaris* in any favourable place. I have found the eggs, larvae and pupae in old watering troughs, stumps of papaya trees, hollow places in logs, broken coconut-shells, etc., more than half a mile from the nearest dwelling. I have never been in the bush at night and do not know how bad a pest it is there. In the house it begins biting early in the evening, often becoming very annoying. Bed-screens are necessary at all times of the year. The mosquitos are persistent in their efforts to get inside of the screens and readily find the smallest tear or opening that has been left when the screen was tucked under the bedding. At daylight they hide away in some darkened place around the bed or on dark clothing that may be hanging in the room. I always collected numbers of them in such places while making my daily morning rounds in search of *S. fasciata*.

Stegomyia pseudoscutellaris is also very common about the house, biting freely during the day and continuing its feeding later in the evening than *S. fasciata* does. It is particularly troublesome in the early evening. It breeds wherever suitable standing water can be found and is the most annoying pest in the field and bush. It is a common custom simply to cut down a papaya tree when the fruit is wanted. The trunk of the tree is divided by septa so that a deep cup is usually left which soon becomes filled with water in which this mosquito delights to breed.

It is not definitely known that *S. pseudoscutellaris* transmits any disease, but it is sometimes a host of the filaria that causes elephantiasis, and further studies may show that it is concerned in the transmission of this disease and possibly of dengue also.

Another species of mosquito which we found on Upolu, while not as common as the others, may prove to be of considerable interest. Dr. L. O. Howard kindly identified this for us as *Finlaya kochi*, Dönitz (*F. poicilia*, Theo.). The

first specimen of this species was captured one morning inside the bed-net, filled with blood. About this time we began to notice that some of the mosquito bites on our hands, faces or legs were much more troublesome than others, producing more irritation and often causing small sores, possibly by secondary infection. While we were not able to connect this mosquito definitely with these more troublesome bites, we believed that it was the offender, as the two things appeared at the same time. The larvae and pupae of this species were found in considerable numbers in the water collected at the base of tamu leaves (Plate XXXI). This large-leafed plant, which is much like taro, is grown in many places and when taro is scarce the roots are often used for food.

Almost or quite as dangerous and troublesome as the mosquitos, are the house-flies, *Musca domestica*, that occur in swarms around the houses and huts and in the fields in Samoa. On wet and cloudy days they are most persistent, swarming around any food that is available and crawling over everyone and everything. Merely waving the hand or a fan close to them will not disturb them. They refuse to fly until the danger of their being struck is most evident. As in other countries, we might look on these flies with more equanimity did we not know that they are so apt to be contaminating our food with typhoid or other germs or distributing over our bodies the organisms that may cause loathsome diseases.

Typhoid is not very prevalent in these islands, but investigation would probably show that many of the cases that do occur could be traced to food contaminated by flies.

Framboesia, or yaws, is quite common, particularly among children, and is known locally as "tona" or "lupani tona". Children badly affected with the sores caused by this disease are seen playing about the houses or streets with other children. The flies which feed freely on the sores doubtless transfer the parasites, *Treponema pertenue*, which cause the disease, to less malignant sores or abrasions on the skin of other children who may thus become infected.

Another dreaded disease that is carried by flies is Samoan conjunctivitis, a disease said to be peculiar to these islands. Again the children are the greatest sufferers. It is a pitiful and disgusting sight, indeed, to see the flies swarming around the sore eyes of so many of the children on the street. The older children sometimes make feeble efforts to drive the flies away, but the little fellows seem to take them as a part of the game, and the flies gather in great numbers, sometimes forming black rings beneath the eyes, and feed undisturbed on the discharges from the affected eyes. The persistent efforts that the flies are always making to get to a person's eyes, whether the eyes are affected or not, is truly remarkable and most exasperating. Only by constant watchfulness can they be kept away.

Blindness in one or both of the eyes is very commonly caused by this disease. White children frequently are troubled with the disease, particularly if they are allowed to play with the native children or are cared for by native nurses whose eyes may be affected. The most efficient remedies promptly applied do not always serve to save the eyesight, therefore most watchful care is necessary.

It is possible that these flies may be responsible, in part at least, for the spread of other less common diseases, but these are enough to show the necessity for some

control measures being adopted if the children are to have the protection which should be theirs.

It is said that the head-louse, *Pediculus capitis*, is very common, but no search was made for them. The Samoans often treat the scalp with lime, sometimes adding the juice of limes also. This is not only very cleansing, but it tends to give a reddish-brown colour to the hair, which is much admired by them. No *Stomoxys* or other biting flies were seen in Samoa. Certainly no effort should be spared to keep them out. Examination of a single rat that had been caught in a trap in a store resulted in the capture of a number of Indian plague fleas, *Xenopsylla cheopis*. This emphasises the necessity of enforcing most rigid quarantine against plague-infected ports. The dogs were badly infested with ticks, *Rhipicephalus sanguineus* (Latr.) being the species taken. This tick has been shown to be concerned in the transmission of malignant jaundice of dogs in South Africa and India. Closely related species of similar habits transmit serious diseases of cattle. As cattle and horses are constantly being imported into Samoa, it would seem most desirable for the Government to have a competent veterinarian there to see that no serious diseases or important pests be introduced in this way.

While Somoa may seem to have more than its share of insects and of insect-borne diseases, it is probably no worse off in this respect then many other groups of islands, and it possesses this advantage: some of the islands, at least, are so situated that the worst of these insect pests could be controlled with a reasonable amount of effort intelligently directed. The diseases which they carry would then gradually disappear. When the Governments, whose duty it is to look after the welfare of the fine race of people that inhabit these islands, realise the conditions there and the possibilities of improving them, something may be done for their protection.

Sagging eave-troughs in which larvæ and pupæ of *Stegomyia fasciata* were abundant.

Hollow in a bread-fruit tree in which larvæ and pupæ of *Stegomyia fasciata* and *S. pseudoscutellaris* were abundant.

A young entomologist discovers the breeding-place of *Finlaya kochi* at the base of tamu leaves.

REPORT ON A SEARCH FOR GLOSSINA ON THE AMALA (ENGABEI) RIVER, SOUTHERN MASAI RESERVE, EAST AFRICA PROTECTORATE.

By R. B. Woosnam,

Game Warden, East Africa Protectorate.

(Map.)

Leaving the Government post on the Amala river, at an altitude of 5,500 feet, on 25th July, I moved down the west bank of the river and camped at a spring known as Ol-otu-lomot, at an altitude of 5,200 feet (*see* accompanying sketch-map). The next day I moved further down the river in search of an old Masai native, by name Ol-botor-ol-joni, who was reported to be familiar with the places in which tsetse-fly (Endorobo of the Masai) was to be found. I found this old man at the place marked on the map and camped there at an altitude of 5,100 feet.

Mr. R. W. Hemsted, the District Commissioner at the Amala post, had visited this area some time previously and had actually caught flies, which he took to be *Glossina*, on the Enderrit river (*see* map), a tiny stream coming down from the escarpment. The flies were put into an empty match-box, but unfortunately all escaped later. Ol-botor-ol-joni had acted as guide to Mr. Hemsted and on his advice I asked the old man again to act as a guide to the places where tsetse-fly were known to exist by the Masai. Ol-botor-ol-joni's manyatta (village) was placed near two small streams and about 300 yards away from the bush which grows along the channels of all the little streams coming down from the escarpment. He owned about 300 cows and oxen and about 500 sheep and goats, and he stated that he and his family, with their cattle, had resided in this district for many years and had come from the Loieta plains to the east of the Amala river. He told me that he knew the tsetse-fly well and that he and the other Masai who lived there knew that it sometimes killed cattle, but he said it did no harm to sheep and goats. They knew very well the places where the fly was, as it had always been there, and they did not take the cattle to those places. In very dry seasons if they were obliged to take the cattle to water at places where there was fly, several men went on ahead and made fires on each side of the track which the cattle would have to use in the fly-area, and set fire to as much of the bush and grass as possible, as they said the fly would not bite the cattle among the smoke or when much of the bush had been burnt and dried up. I afterwards saw the remains of numbers of these fires in the fly-areas.

The Masai also told me that sometimes when they wished to move cattle through a fly-area, they did so at night; this I doubt, because lions are very numerous throughout these districts and I have never heard of Masai letting their cattle out of the manyatta at night. Besides this, it so happens that in the present case the precaution would not appear likely to be successful. The *Glossina* in question has been identified by Mr. E. E. Austen as *G. fusca*, Walk., and

belongs to a group of species which are more or less crepuscular in their habits. It is possible therefore that this fly may continue its activities throughout the night, in the same manner as *G. pallidipes* does in the coast regions of British East Africa. From personal experience I can testify to the fact that *G. pallidipes* feeds greedily during the whole night, bnt, in my experience, not during the day-time. The possibility that the tsetse-fly on the Amala river feeds principally during the night is borne out by the fact that I failed to capture a single specimen during a whole day's search, as I shall describe later; but I was unable to search at night.

While I was discussing the distribution of tsetse-flies with Ol-botor-ol-joni and several other Masai from his village, one of my porters, who had all been instructed to catch any flies which might bite them, brought me a large *Tabanus* (probably *T. ustus*) which he had caught biting his leg. I showed the fly to the Masai, and Ol-botor-ol-joni at once said that it was not a tsetse-fly (Endorobo); some of the Masai present agreed with him, but others insisted that it was a tsetse-fly. However, one of them, in order to settle the dispute, volunteered to go and catch a tsetse. He went away and within half an hour returned with a leaf folded up and tied with grass, in which he said there was a tsetse-fly. I put the leaf into a killing bottle and in due course opened it, and found inside it the only tsetse-fly which I obtained during the expedition. This fly was caught at about 3.30 p.m. (I was able to spend only one whole day in the fly-areas as I was obliged to return to meet His Excellency the Governor at a certain time.)

As soon as I saw this one tsetse-fly I asked its captor if he could show me any more, which he said he was confident he could do. So I at once set out with him and took with me a donkey and a very dark-coloured mule. We proceeded to the bush along the course of one of the little streams near by, where I was assured there were always tsetse-fly to be found, and where the one specimen I obtained had been caught. I remained there from 4.30 p.m. until dark, moving the mule and donkey slowly about among the bush and down the bed of the stream, remaining stationary now and then for ten minutes. Not a biting fly of any kind was to be seen, except *Haematopota*, *Stomoxys*, and *Lyperosia*.

The next morning I started at about 8 a.m. with the mule and donkey, and most carefully hunted several of the places where the Masai told me tsetse-fly were always to be found. I failed to obtain a single specimen, although I remained there until 4 p.m., when I was obliged to return to my camp 10 miles up the river. Several other genera of blood-sucking flies were seen. A large *Tabanus*, which I believe is *T. ustus*, was numerous, and *Haematopota*, *Stomoxys*, and *Lyperosia* were seen and captured. A few specimens of *Tabanus maculatissimus* were seen, but they were very shy and only one was caught. One specimen of the genus *Chrysops* was seen, but escaped. These blood-sucking flies all appeared after 11 a.m., and at about 12.30 a.m. one single *Glossina* appeared and settled low down on the mule's leg, but did not feed, and disappeared instantly, although I made no movement to catch it, as I was anxious to allow the mule or donkey to be infected if possible, in order to take the strain of trypanosome back to the Government Laboratory at Nairobi.

The Masai showed me all the areas where they knew from experience tsetse-fly existed. These are shown on the accompanying sketch-map, but there are probably more streams than are indicated on the map. After discussing the subject carefully with the local Masai, I came to the conclusion that, although they only knew tsetse-fly to exist on some of the small water-courses coming down from the escarpment and on the Amala river, they nevertheless wisely treated all these small water-courses with suspicion, except in the case of sheep and goats, and only approached them with their cattle if compelled to do so for want of water. They told me that tsetse-fly was to be found all down the Amala river from this point into German territory, and that although it was far more numerous during the rains it was always present all the year round. Some of the Masai insisted that the fly only existed on the west bank of the river, others said it was to be found on both banks. This is a very interesting point in view of the fact that two previous attempts to find this tsetse-fly on the Amala had failed, and also because the phenomenon of tsetse-fly existing on one bank of a river and not on the other has been reported from other parts of Africa.

In October 1912, I visited this portion of the Amala for the first time, and travelled down the east bank as far as the bend in the river where "Judd's old store" is shown on the map. Knowing that tsetse-fly were said to exist here I searched carefully all down the east bank of the river from the Government post to the lower store. I failed to find any trace of *Glossina*, and six mules, a pony and two dogs which I took with me all down the edge of the river were not infected and are still alive and well. I did not cross to the west side of the river. Both my visits to the Amala were made during the dry season (which extends from about the middle of June or end of May till November or December, or in bad years till March), and on the west bank tsetse-fly in small numbers were discovered, while on the east bank none could be found. Of course it is quite possible that owing to the dry season and there being few flies about, tsetse may have been on the east bank of the river without being detected on the occasion of my first visit; but there is other evidence which makes this unlikely.

In May 1913, during the rainy season, Mr. T. J. Anderson, Government Entomologist, visited the Amala river with the object of investigating the reported presence of *Glossina*. He approached the river from the east, and followed that bank from near the Anglo-German border up to the Government post above Judd's store. He found no signs of tsetse-fly at any part of the Amala which he visited, and I attribute this to the fact that he was unable to cross to the west bank owing to the river being in high flood. Mr. Anderson's visit was made at a season when tsetse-fly should have been numerous and in evidence if they exist on the east bank of the river.

Further than this, there is the evidence to be drawn from the case of the store-keeper Judd, who had a trading station at the bend of the river marked on the map. He occupied and used this store for 18 months, dealing in sheep, goats and cattle from the natives, and also had mules and ponies from time to time at the store.

In March 1911, during the rains, two mules and four horses were kept at the lower store, and were used on *both sides* of the river hunting lions for 15 days. None of these animals died.

In May 1911, five mules were taken to the lower store and used on a hunting expedition *down* the river on the east side only. It is noted in Mr. Judd's diary that several kinds of biting flies were very troublesome, but no tsetse-flies were seen, and Mr. Judd is thoroughly familiar with these insects. However, one of these mules became ill, and upon its return to Nairobi in June it was examined at the Government Laboratory, and found to be infected with trypanosomes and died later.

In June and July, two teams of ten mules were doing transport work between Nairobi and the lower store, using a road which did not approach the river until it reached the store. It is said that none of these animals crossed the river, but they drank daily at a ford near the store where the river is not more than 30 yards wide. Five of these mules became ill and died, but they were not examined for trypanosomiasis. They used to remain four or five days at the store before returning to Nairobi. After this, mules were no longer used and a team of 18 oxen was tried under similar circumstances. Seven of them became ill and five died; but they were not examined for trypanosomiasis. They were said never to have crossed the river, but drank at the ford daily.

In November 1912, Judd moved his store some 15 miles higher up the river, on account of having lost so many animals from suspected trypanosomiasis.

All this evidence tends to show that the tsetse-fly in the area under discussion is either confined to the west bank of the river, or to that bank and the east bank in the immediate vicinity of the river, and this theory is strengthened and explained when the physical features and conditions of vegetation in this area are taken into consideration, which I shall describe later.

When I was obliged to leave this district, I told the old Masai who had acted as guide that if he could catch some more tsetse-flies and would bring them up to the Government post he would receive five rupees and I left him a box in which to put them. I am glad to say that about ten days later he brought in three flies which were sent in to Mr. Anderson according to my instructions. They proved to be *Glossina*, of the same species as the one first obtained, and they were sent by Mr. Anderson at once to Mr. Guy Marshall in London.

The old Masai, Ol-botor-ol-joni, who undoubtedly knows a tsetse-fly at once by sight and who also knows a good deal about them and their distribution, told me that there was another species of tsetse-fly to be found in this area, which was much smaller and of a lighter brown colour, but it was not so numerous and was very shy. I shall endeavour to obtain this fly, which of course may not be a *Glossina*. However, I showed the old man several *Haematopota* and *Stomoxys*, which he said were not at all like it.

When I arrived first at Ol-botor-ol-joni's village I found that he was said to be ill and he was unable to accompany me as guide on this account. As he had evidently spent a good deal of his time in the fly-areas I thought it worth while taking some smears of his blood. I had some difficulty in persuading him to submit to this, but eventually he allowed me to draw a little blood from his finger. I examined this while fresh under a cover slip and also in stained preparations, but could find no trypanosomes, after spending two hours over each of the stained slides. He said he had been ill for about ten months. He complained of pain in his head and stomach and back. He showed marked

oedema in the feet and ankles, but I could find no trace of enlarged cervical glands and he showed no signs of emaciation. He was a man past middle age and had a little grey in his hair, but I believe he was suffering from nothing more than advancing old age. On enquiring as to whether these Masai knew or suspected the tsetse-fly of producing disease or death in human beings, I could find no evidence of any idea of the kind. They knew and admitted that they occasionally lost cattle as a result of their being bitten by tsetse-fly, but they said this very seldom happened and that they had no cattle sick at the time. I saw the cattle and could find none showing signs of disease. Among the sheep and goats I found two, one sheep and one goat, which were diseased and much emaciated and were said to have been ill for three months. I examined the blood of both these animals, but could find no trypanosomes.

Physical Features of the Fly-area.

The Amala river from the Government post at 5,500 ft. flows with considerable current as far as the point on the map marked "rapids." There is no dense bush or forest on this part of the river, only a very narrow fringe of trees and bush actually on the edge of its banks. At the point where the rapids are, the escarpment of 6,000 ft. altitude, which runs all along the west bank of the river into German territory, approaches the river within 200 yards. Above this point tsetse-fly do not occur. Immediately below it the escarpment bends away from the river, as can be seen from the map, and the west bank opens out into a broad plain of park-like country, fine grazing land, studded with occasional yellow-barked acacia trees. At the lowest point I reached, just below the Enderrit river, there was a distance of at least seven miles from the Amala river across the plain to the escarpment, with a fall of about 200 ft. from the foot of the escarpment to the river, and below this point the distance is much greater.

This plain is intersected by numerous small water-courses coming down from the escarpment, some of which contain a little running water all the year round from springs, while others dry up, except for a few pools, towards the end of the dry season. The banks of all these water-courses are over-grown with dense bush and forest, at the sources extending for perhaps only 30 to 50 yards on each bank, but gradually widening out as the streams approach the Amala to as much as 250 or 300 yards. This bush is very similar to bush in which I have seen *G. palpalis* in Uganda and the Congo, and is in every way suitable for tsetse-fly. It consists of some large forest trees, with smaller ones in between and with quantities of creepers, affording excellent shade, which in some places is very dark, in others mottled with sun-light. This forest is not full of dense undergrowth, but is comparatively open, so that it is possible to walk about and even lead a mule without much difficulty. There is no grass growing beneath the trees, though in some places there is a thin growth of low herbaceous plants, but more usually the ground is covered with dry leaves and composed of leaf-mould. The temperature in this bush, taken only upon one occasion, registered 80° F. maximum and 58° F. minimum, at an altitude of 5,100 feet. The soil underneath these belts of bush apparently never becomes very dry and in some places is quite sodden, so that there is ample moisture combined with the shade.

The Masai reported that tsetse-fly existed upon some of these water-courses from the foot of the escarpment all the way down to the Amala river, but that on others no fly occurred. Owing to my having been able to spend so short a time in the area, I can neither prove nor disprove this statement; though I am more inclined to the opinion that fly exists on all these little water-courses, but that it follows some of them nearer to the escarpment than others, and that as the Masai avoid as far as possible taking their cattle down towards the Amala, they have only come in contact with fly on some of the streams.

Immediately below the rapids on the Amala there is a considerable area of bush, as shown on the map, which the Masai state is a fly-area, and it is consequently interesting to note that a broad well-used cattle track passes through the middle of this patch of bush.

Between the rapids and Judd's lowest store at the bend of the river, the Amala changes its character and becomes a very sluggish river, running in a deep narrow channel between high banks. There is very little fall in this part of the river, the country is flat and there is a great deal more bush on this portion of the east bank than upon any other part I visited, and it is quite possible that here both banks of the river are infested with tsetse-fly. However, I camped here in October 1912, and found no *Glossina*, nor did Mr. T. J. Anderson, who passed along this part of the river in May 1913. Throughout this section of the river the west bank has far the most extensive area of bush; this is continuous with the bush along the small water-courses, already described, which run into this part of the river on the west side. On the east bank there are several small water-courses running into the river, but they are quite dry except during the rains, and are rocky and have no bush at all on their banks, or only an occasional clump a few yards in diameter.

The whole character of the east side of this part of the river is different from that of the west. The ground is more rocky and arid, more undulating, and rises higher and more abruptly above the river. The grass is less luxuriant, and the country cannot be described as park-like, being extensively covered with thinly scattered thorn scrub of several dark rough-barked varieties of acacia and not the tall yellow-barked species.

At the bend of the river at Judd's lower store, or a little above this, the Amala again flows fairly swiftly over a rocky bed, and the banks, particularly on the east side, have little or no bush upon them, only a fringe of trees along the water's edge and scattered thorn scrub further from the river. How far these conditions continue I cannot say, as I have never been below this bend. On the west side of the river at Judd's lower store there is a considerable rocky ridge, which causes the river to take the bend to the east and appears to separate it at this point from the plains below the main escarpment.

The Amala river at this point is about 75 or 80 miles in a direct line from Lake Victoria, and it must flow for 150 or 200 miles before falling into the lake.

There are large numbers of game and other animals on both sides of the Amala in the portion investigated, the following species being represented:—Rhinoceros, hippopotamus, giraffe, eland, waterbuck, zebra, roan antelope, wildebeest, topi, Coke's hartebeest, impala, reedbuck, bushbuck, steinbuck, oribi,

duiker, lion, leopard, cheetah, serval cat, wart-hog, baboons and other monkeys, hares, and numerous other small mammals ; also birds, such as guinea-fowl and francolin, but few large water-birds.

In the fly-area blood smears were obtained from topi (probably the most plentiful game animal), impala, zebra, wart-hog and a hare. On examination later, none of these was found to contain trypanosomes.

Conclusions.

The tsetse-fly area on the Amala river appears to present several points of interest :—

(1). The species of tsetse-fly is the western *Glossina fusca*, which has never been recorded previously from the East Africa Protectorate.

(2). The altitude, 5,200 ft., is the highest at which any species of *Glossina* has at present been found to exist permanently.*

(3). The fly on the upper part of the river, the area under discussion, is apparently confined to the west bank, or only occasionally strays to the east bank.

(4). Natives with their cattle, sheep and goats have been living for many years practically in contact with the fly (I have myself seen large numbers of cattle grazing within 400 to 500 yards of belts of bush in which tsetse-fly undoubtedly exist all the year round), in spite of the fact that several visiting sportsmen have lost mules and trek-oxen as the result of an expedition down the Amala river, and that the natives themselves admit that they occasionally lose a few cattle from the bites of tsetse-fly (Endorobo).

(5). There appear to be two possible explanations of the phenomenon of natives with their cattle living among fly-areas in which at least a percentage of the flies are known to be infected with a trypanosome pathogenic to cattle, mules and horses :—

(*a*) It is possible that the natives in this district are so familiar with the distribution of the tsetse-fly that they scarcely ever expose their cattle to infection. The fly certainly appears to be confined to very definite and distinct areas and it has been stated that if the natives are at times compelled to visit these areas for water, this only occurs during very dry weather when the fly is least numerous and active. Where the escarpment on the west bank is within about two miles of the river, the Masai have their villages and cattle kraals on the top of the escarpment, only bringing their cattle down to water. This, however, is above the fly-area.

(*b*) It is possible that only a very small percentage of the tsetse-flies present are infective. This might be accounted for in two ways. Either the reservoir or source of infection is very limited, or owing to unfavourable climatic conditions (possibly the rather high altitude), the flies themselves have very little power of what Roubaud calls

*[Roubaud has recorded (Bull. Soc. Path. Exot. vi, no. 5, 14th May 1913) that in the Paris Museum there are many specimens of the *fuscipes* form of *G. palpalis* collected by Cronier on the volcanos of Kivu, in the Belgian Congo, at an altitude of 5,000 to 5,500 feet.—Ed.]

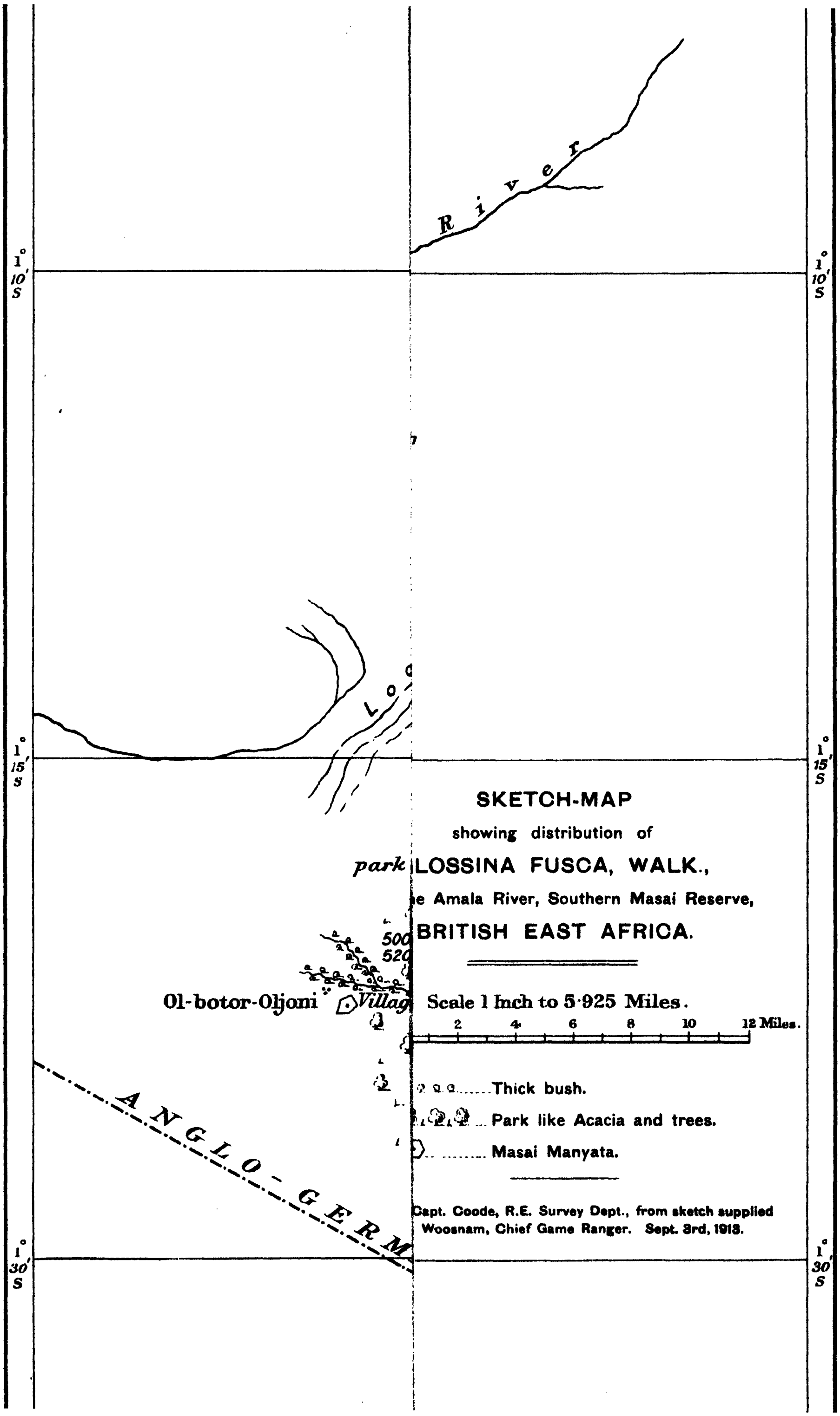
"receptivity"; that is to say, numbers of flies may feed upon an infected animal, while only a very small percentage of them becomes infective.

Recommendations.

The fact that a portion of the trans-Amala area of the newly extended Masai Reserve is inhabited by tsetse-fly does not at present appear to be of any importance or a cause for alarm on account of the natives or their stock, because there are already numbers of Masai who have lived in this area for many years without suffering any appreciable loss. Consequently no precautionary or protective measures appear either necessary or possible. It might perhaps be considerate, and to some extent a precaution, to warn the newly arriving Masai clearly that tsetse-fly does exist in certain areas and that they must keep their cattle away from these places. But this information they will certainly obtain from the present inhabitants of the district, and it is unlikely to be received with much belief or appreciation when coming from a white man.

Further, it does not appear advisable, if it can be avoided, to allow natives coming from the lake shores, and possibly suffering from trypanosomiasis in an early stage, to visit the area in question until more definite knowledge has been obtained about the tsetse-fly (possibly two species) on the Amala river. There are apparently only two ways in which this might come about. The most probable way is that owing to a road having been lately opened up from the Amala post to Kisii, the District Officers will employ, as porters, natives from Kisii, Homa Bay and South Kavirondo, among whom it is just possible there might be an unsuspected case of sleeping sickness. If District Officers use such porters for journeys down the Amala river it might be worth while avoiding the fly-area under discussion so far as possible.

The other way in which an unsuspected case of sleeping sickness might conceivably be brought into the fly-area would be among the porters employed by shooting parties, of which a few visit the Amala river annually. It appears difficult, if not impossible, to prevent this, and it must be remembered that these shooting parties with Kavirondo porters have been visiting the Amala river for years. However, sportsmen who get into difficulties with tsetse-fly on the Amala do so from ignorance and not from any desire to enter a fly-area. Up to the present, it has never been clear where the fly existed on the Amala. If a copy of the accompanying map is allowed to be supplied to the agents in Nairobi who fit out shooting parties, they will give the necessary warning, with the result that this fly-area will be avoided so far as possible by shooting parties and travellers, to the advantage of all concerned.

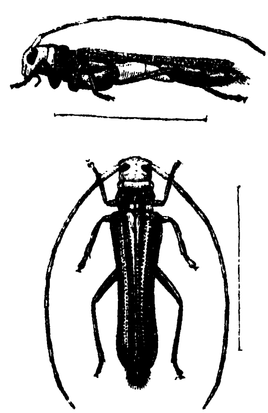

River
Lo
SKETCH-MAP
showing distribution of
park LOSSINA FUSCA, WALK.,
e Amala River, Southern Masai Reserve,
BRITISH EAST AFRICA.
500
520
Ol-botor-Oljoni
Villag
Scale 1 Inch to 5·925 Miles.
2 4 6 8 10 12 Miles.
Thick bush.
Park like Acacia and trees.
Masai Manyata.
ANGLO-GERM
Capt. Coode, R.E. Survey Dept., from sketch supplied
Woosnam, Chief Game Ranger. Sept. 3rd, 1913.
1° 10' S
1° 15' S
1° 30' S

THE YELLOW-HEADED COFFEE BORER (*DIRPHYA (NITOCRIS) PRINCEPS*, JORD.)

By C. C. Gowdey, B.Sc., F.E.S., F.Z.S.,

Government Entomologist, Uganda.

The first time that this beetle proved itself to be a pest of coffee to any great extent in this country was on native coffee, *Coffea robusta*, in the Chagwe District, in 1910, at which time I began to investigate it. Since the first outbreak it has been found attacking *C. arabica* on several estates. Some of the estates have suffered serious damage, especially the older ones which are badly affected by the coffee leaf-disease, *Hemeleia vastatrix*. With a single exception, I have been able to trace the origin of the outbreak to plots in which leaf-disease was already present and in which, consequently, the trees were the least vigorous.



Dirphya princeps, Jord.

I have called the beetle the Yellow-headed Coffee Borer, to distinguish it from the other coffee borers of the family Bostrychidae. It belongs to the family Cerambycidae, subfamily Lamiinae, division Phytoeciides. *Dirphya* (*Nitocris*) is an Ethiopian genus well represented in Uganda, where there are at least eight other species; but the only common species is *D. delecta*, Gahan, from which, however, *D. princeps* can be easily distinguished. I do not know the food-plants of any of the other species of *Dirphya*. In German East Africa, according to Morstatt,* *D. usambica*, Kolbe, is also responsible for great injury to coffee.

Description.

The egg is light brown in colour, 3·2 mm. in length, 1·1 mm. in breadth.

The larva is ivory-coloured; head well formed, wider than the body, dark brown, with sharp black mandibles; segments of the body with protuberances on the dorsum, last segment sparsely hirsute. Length 30 to 33 mm.; breadth 4·2 mm.

* "Der Pflanzer," 1911, No. 5.

The pupa is dark brown and somewhat larger than the adult.

The beetle is black, with the exception of the head and the anterior border of the prothorax, which are yellow ; antennae somewhat longer than the body, basal segment yellow, remaining segments black, shading to brown near tips ; elytra black, apex brownish black, with rows of punctures ; wings black, protruding slightly beyond the elytra ; venter black, basal half covered with silvery hairs ; legs black. Length 34 mm. ; female slightly larger than male.

Life-History.

The female beetle loosens a bit of the bark on a branch, from four to six inches from the tip, and lays its eggs under the bark. The eggs are deposited singly.

The young larva bores into the branch until it reaches the wood on which it feeds and continues boring its way to the stem. It then turns downwards, forming a large tunnel which often cuts into the cambium. The tunnels in the stem continue to the surface of the ground and often extend into the main root, being sometimes as much as four feet in length. The larva is very agile, ascending or descending in its tunnel with great rapidity. At distances varying from two to four or five inches, horizontal tunnels are bored running from the vertical tunnel to the outside of the branch or stem. The exits of these tunnels are about 1·5 to 2 mm. in diameter, and are all on the same side of the tree. They are made for the purpose of getting rid of the frass (excrement and wood dust).

When full growth is attained the larva ascends the tunnel for about half an inch and forms a pupal chamber by constructing a partition above and beneath. The reason for this ascent is probably to escape the slight moisture which may collect at the bottom of the tunnel. As soon as the transformation from the pupa to the beetle is completed, the latter eats its way out of the stem. The beetle has not been observed to feed either on the leaves or on the bark.

As is usual with members of this family, the life-history is a very protracted one. My observations lead me to the conclusion that it occupies between two and three years, and larvae of various sizes can be found throughout the year. The pupal stage lasts for from seven to nine weeks, usually from November to December.

Treatment.

It is an easy matter to locate the trees that are attacked by this borer, as the frass can be quickly observed near the base of the trees. The branch through which admittance to the stem is gained can usually be detected without difficulty, either by the openings of the horizontal tunnels or by the tips of the branches being black. The latter, however, is not a sure indication of the presence of the grub, as the blackening may also be due to the 'die-back' fungus.

If the presence of the grub is detected in the branch before it has reached the stem, the obvious and easiest way to get rid of the insect is to cut off the branch and burn it. It is not an easy matter, though, to discover the insect at such an early stage. On the other hand, if the presence of the grub is not detected before it

reaches the stem, the control measure which I have recommended and which has been successful in every case, is to inject a few drops of carbon bisulphide or carbon tetrachloride into the tunnels of the borer. This operation is best carried out by first sealing up all the exits of the horizontal tunnels in the stem with wet clay, and then cutting off the branch through which the insect entered the stem, as close to the stem as possible; this will expose a large hole through which a few drops of the liquid can be conveniently injected, the hole being then sealed up with wet clay. A bicycle oil-can will be found to answer the purpose of an injector very satisfactorily. As the vapour of both carbon bisulphide and carbon tetrachloride is heavier than air, it sinks rapidly to the bottom of the tunnel and kills the insect. The former substance is *extremely inflammable* and, consequently, the operator should not open the bottle containing this liquid while near a fire or when smoking. After the operation is finished it is advisable to brush away the wood dust from near the base of the trees, for then if no wood dust is found on the next visit it may be concluded that the insect is dead. It may often be found necessary to repeat the operation a second, or even a third time, as the stem may be attacked by another borer entering it from another branch after the first injection. Neither of the above liquids has any deleterious effect on the trees.

The treatment adopted in German East Africa for *D. usambica* (Morstatt, *l.c.*) is either to inject the trees with an oil, usually paraffin, or to cut into the vertical tunnel in the stem of the tree a little below the last horizontal tunnel and to spear the insect with wire. The former method is unsatisfactory, for in order to obtain the required result the body of the insect has to be covered more or less with a film of oil and this is not so easy as it may appear. The latter has the disadvantages that it is a tedious operation, and that it is not advisable, especially in the case of two-year-old trees, to make the deep incision that is necessary.

Trees attacked by *D. princeps* if allowed to remain untreated are either killed outright or broken off by the wind on account of the extensive tunnelling. This insect does not appear to attack trees younger than two years old.

NEW AFRICAN TABANIDAE.—PART IV.*

By Ernest E. Austen.

(*Published by permission of the Trustees of the British Museum.*)

The types of the seven new species described in the following pages are in the British Museum (Natural History). The subjoined list shows the countries in which the species have been obtained.

PANGONIINAE.

Genus Chrysops, Mg.

Chrysops pallidula, sp. n.	... ...	Angola.

TABANINAE.

Genus Haematopota, Mg.

Haematopota hastata, sp. n.	... ...	Sierra Leone Protectorate; Gold Coast (Northern Territories); Northern Nigeria.
,, *harpax*, sp. n.	... ...	Belgian Congo.
,, *maculosifacies*, sp. n.	...	German East Africa.
,, *ingluviosa*, sp. n. ...	...	Southern Rhodesia; Northern Rhodesia.
,, *edax*, sp. n.	... ...	Uganda Protectorate.
,, *nigripennis*, sp. n.	...	Uganda Protectorate.

PANGONIINAE.

Genus Chrysops, Meigen.

Chrysops pallidula, sp. n. (fig. 1).

♀.—Length (5 specimens) 8 to 9·5 mm.; width of head just under 3 to 3·2 mm.; width of front at vertex 1·2 to 1·25 mm.; length of wing 8·2 to 9 mm.

Medium-sized, broadish species, with very distinctive coloration; dorsum of thorax light isabella-coloured, dorsum of abdomen cinnamon-coloured, with a whitish-grey transverse band at base of second segment, as shown in fig. 1.——*Face entirely whitish- or yellowish-grey pollinose, devoid of a shining tubercle or tubercles; dark wing-markings as shown in* fig. 1, *dark brown or clove-brown,*† *stigma elongate and paler, raw-umber-coloured; legs ochraceous or tawny-ochraceous, trochanters, front tarsi, last two joints of middle and hind tarsi, and tips of front and middle coxae, of all femora and tibiae (narrowly), as well as extreme bases of all tibiae and tips of first three joints of middle and hind tarsi clove-brown.*

---

* For Part III, *see* Bull. Ent. Res., Vol. iii, p. 399 (December, 1912).

† For names and illustrations of colours, *see* Ridgway, "A Nomenclature of Colors for Naturalists." (Boston: Little, Brown & Company, 1886.)

Head: front slightly narrower above, face broad below, clothed like jowls and basioccipital region with whitish hair; front above callus yellowish-grey, clothed with clove-brown or blackish hair, hind margin of vertex clothed with whitish hair; *frontal callus* shining clove-brown, transversely elongate and extending almost from eye to eye, its antero-posterior diameter only about one-fourth the length of its transverse diameter, its upper and lower margins parallel; on upper portion of front a narrow, shining clove-brown, transversely elongate callus extends outwards from each posterior ocellus, tapering towards its outer extremity and not reaching the eye; a small, shining clove-brown, median spot

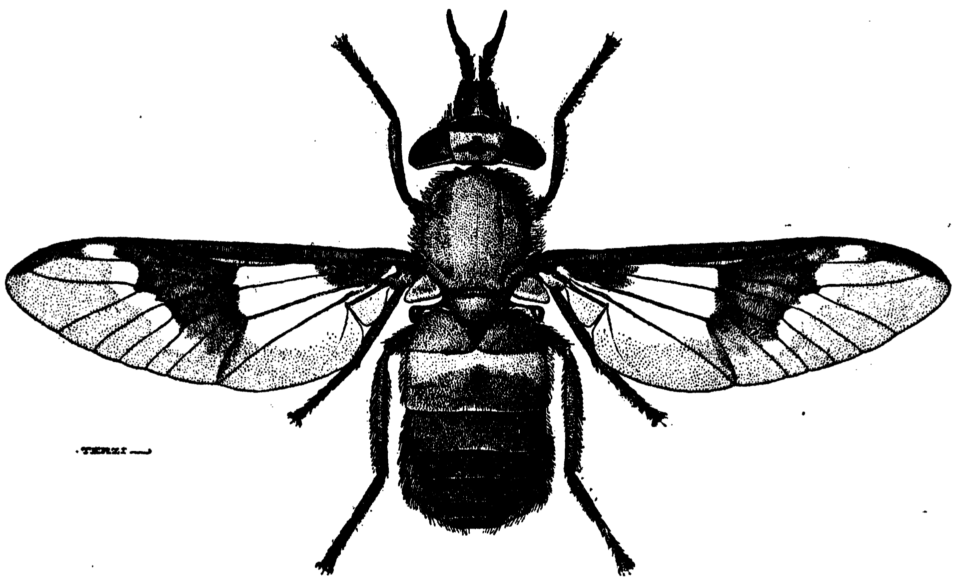


Fig. 1.—*Chrysops pallidula*, Austen, ♀. × 6.

is also visible in front of and in contact with the anterior ocellus; proximal joint of *palpi* mouse-grey, clothed with whitish hair, terminal joint drab-grey, of moderate size, clothed with silvery-white hair and bluntly pointed at distal extremity; first joint of *antennae* short and swollen, clothed above with clove-brown or blackish and below with whitish hair; upper surface of first joint of antennae usually dull raw-sienna-coloured, more or less overspread with slate-grey, under surface of first joint buff or cream-buff, but sometimes first joint entirely slate-coloured above and only narrowly cream-buff below; second joint of antennae short and stout, either entirely slate-coloured or blackish slate-coloured, except at extreme base below, or slate-coloured above and buff below, hairy covering of second joint agreeing with that of first joint; third joint of antennae clove-brown or blackish clove-brown. *Thorax:* scutellum greyish cinnamon- or greyish fawn-coloured; pleurae and pectus smoke-grey; thorax entirely clothed with whitish hair, which is shorter on dorsum than on pleurae. *Abdomen:* dorsal scute of first segment with a median slate-grey spot at base, not reaching hind margin and largely concealed by scutellum; whitish-grey transverse band on dorsal scute of second segment deeper towards each lateral

extremity than in centre; transverse band clothed with minute, appressed, whitish or silvery-white hairs, and a small and not sharply defined patch of similar hairs usually more or less distinctly noticeable in centre of hind margins of dorsal scutes of second and third segments; dorsum elsewhere clothed with minute, appressed, ochraceous hairs; lateral margins of dorsal scutes of first and second segments clothed with longer, whitish hairs, those of dorsal scutes of fourth and fifth segments clothed with outstanding dark brown hair; venter greyish-buff, clothed with minute, appressed, glistening, cream-buff hairs. *Wings:* a broad hind border, extending from dark brown apical fleck to distal extremity of axillary cell, grey; between this hind border and distal margin of transverse band, from marginal to third posterior cell, is a milky stripe which follows outline of transverse band.* *Squamae* isabella-coloured. *Halteres:* knobs sepia-coloured or mummy-brown, stalks isabella-coloured. *Legs:* front coxae cream-buff, middle and hind coxae smoke-grey; tibiae not incrassate; all coxae, and middle and hind femora except distal extremities clothed with whitish hair, remainder of legs clothed with blackish hair, hind tibiae fringed on outer side with fine black hair.

ANGOLA: type and four other specimens from Lepi, Benguella (390 kilometres inland from Lobito Bay), alt. 3,500 feet (collected and presented by *E. Robins*).

Chrysops pallidula is evidently allied to *C. inflaticornis*, Austen, which is found in the Cape of Good Hope Province of the Union of South Africa. While, however, these two species resemble one another in the shape of the head, coloration of the abdomen, and general pattern of the wing-markings, *Chrysops pallidula* can be distinguished from *C. inflaticornis* by, *inter alia*, the first joint of the antennae being less swollen, the dorsum of the thorax being paler and devoid of conspicuous longitudinal stripes, and by the apical fleck in the wing being narrower, darker, and much more sharply defined.

TABANINAE.

Genus HAEMATOPOTA, Meigen.

Haematopota hastata, sp. n. (fig. 2).

♂ ♀.—Length, ♂ (10 specimens) 8·5 to 10 mm., ♀ (14 specimens) 8·25 to 10 mm.; width of head, ♂ 3·4 to 4 mm., ♀ 2·8 to 3·5 mm.; width of front of ♀ at vertex just over 1 to 1·2 mm.; length of wing, ♂ 8 to 9 mm., ♀ 8 to 9·8 mm.

Medium-sized, dusky species, with dark wings marked with compound rosettes, large and conspicuous antennae in the ♀, the third joint (including terminal annuli) in this sex being flattened from side to side and consequently very broad from above downwards (see fig. 2a), *and in both sexes with a clove-brown transverse band on face immediately below antennae, and with hind tibiae marked with a single narrow pale band near base, though indistinct traces of a second band on distal half are sometimes visible.*

Head: light grey pollinose; *front* in ♀ fairly broad (slightly wider anteriorly), sepia-coloured or mouse-grey except lateral margins and a narrow median stripe running from vertex to median frontal spot, which is distinct and surrounded by

* In fig. 1 the milky stripe is incorrectly shown as extending into the fourth posterior cell.

anterior extremity of median stripe; clove-brown lateral frontal spots in ♀ conspicuous, in contact with or narrowly separated from eyes; jowls and basi-occipital region in both sexes clothed with whitish hair; clove-brown transverse band on face extending from eye to eye, and in ♂ clothed with brownish hair; pair of small, clove-brown, admedian, elongate spots between and above bases of antennae present in both sexes; *frontal callus* wanting in ♂, in ♀ dark brown or mummy-brown, not very deep from above downwards but shaped like a transverse band extending from eye to eye; *eyes** bare in both sexes, enlarged facets in ♂ for most part very large and coarse; proximal joint of *palpi* darkish grey, mouse-grey, or isabella-coloured, clothed in both sexes with whitish hair, terminal joint of palpi in ♂ elongate-ovate, isabella-coloured and clothed with long brownish hair sometimes mixed with yellowish or whitish hair, terminal joint of palpi in ♀ drab-grey, occasionally darker on outer side towards distal extremity, moderately swollen towards base, and clothed on outer side with

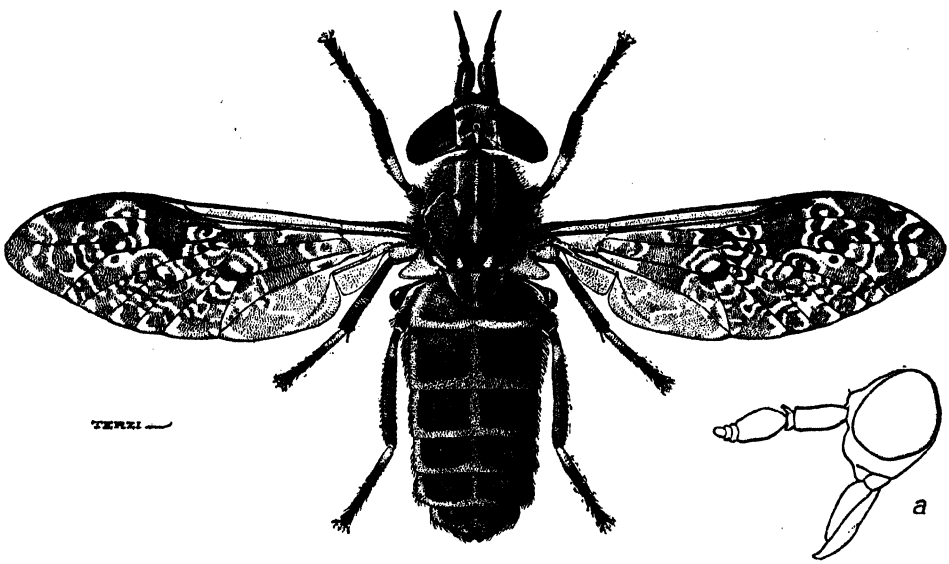


Fig. 2.—*Haematopota hastata*, Austen, ♀. × 6.

minute, appressed, black hairs, mixed with minute, glistening yellowish hairs; *antennae in* ♂ *agreeing in shape with those of* ♀ (*see* fig. 2a), but about one *half the size*, first joint of antennae in ♂ mummy-brown or dark brown, greyish pollinose above and on inside and shining on outer side, clothed above and below with long dark brown hair, second joint of antennae in ♂ mummy-brown or cinnamon-coloured; third joint of antennae in ♂ mummy-brown (terminal annuli clove-brown), upper and lower margins of proximal half of expanded

* Coloured sketches of the eyes of this species in life, made at Ilorin, Northern Nigeria, by Dr. J. W. Scott Macfie, W.A.M.S., show that in the ♂ the upper (large-facetted) portion is pale fawn-coloured, speckled with a darker tint, while the lower border, which is composed of small facets, is darkish purple with two horizontal, greenish metallic bands, the upper of which is sinuous; in the ♀ the eye, which, as in other Tabanids, is of the same colour as the small-facetted lower border in the ♂, bears four horizontal, greenish metallic, sinuous bands.

portion, except at base, clothed with minute black hairs; first joint of antennae in ♀ (*see* fig. 2a) large, swollen and cylindrical, dark brown or dark mummy-brown, more or less greyish pollinose on inner side, elsewhere shining, sparsely clothed above and below with short, dark brown hair; second joint of antennae in ♀ agreeing in coloration with foregoing though occasionally paler, with exception of its upper and lower angles, which are often much produced; third joint of antennae in ♀ shaped as described in diagnosis above, its expanded portion clove-brown, the terminal annuli blackish. *Thorax:* dorsum dark sepia-coloured, with narrow grey markings as shown in fig. 2, and sparsely clothed with minute, appressed, yellowish hairs, which in case of ♂ are mixed with longer fine and erect brownish hair; pleurae and pectus smoke-grey or mouse-grey, clothed almost entirely with either brownish or whitish hair, or partly with brownish and partly with whitish hair. *Abdomen:* first three or first four dorsal scutes in ♂ seal-brown, remainder clove-brown, hind borders of second, third and fourth segments in ♂ smoke-grey, each expanded in middle line into a forwardly directed triangle, which may contract into a narrow median stripe, extreme hind margins of fifth and following dorsal scutes in ♂ yellowish-grey or smoke-grey, fifth and sixth dorsal scutes in ♂ each with a pair of elongate grey spots; dorsum in ♀ clove-brown, with conspicuous grey markings as shown in fig. 2, and with lateral extremities of first four scutes broadly grey; dorsum in ♂ clothed with dark brown or brownish hair, mingled with yellowish hairs on grey hind borders of third and following segments, dorsum in ♀ on clove-brown areas clothed with minute, appressed hairs of similar colour, on grey hind borders sparsely clothed with appressed pale yellowish hairs, and on lateral extremities of first three scutes clothed partly with appressed and partly with outstanding hair of same colour; venter in ♂ greyish mummy-brown proximally, greyish clove-brown distally, clothed with minute, appressed dark brown hairs, which on third and fourth segments and posterior angles of fifth segment are sometimes replaced by glistening yellowish hairs, venter in ♀ grey from base to hind margin of second segment, then greyish clove-brown, clothed on third segment with minute, appressed yellowish hairs, and on fourth and following segments with minute, appressed blackish hairs. *Wings:* sepia-coloured, with light markings shown in fig. 2 well developed and conspicuous; apical sinuous mark double, or at least showing a trace of a second mark beyond principal one; *stigma* elongate, well developed and conspicuous, dark brown, its proximal extremity pale; quadrate dark blotch below stigma conspicuous, unbroken, and well defined, though not always actually darker than remainder of ground colour; veins mummy-brown or dark brown, anterior transverse vein, extreme base and base of fork of third longitudinal vein, fifth longitudinal vein before its bifurcation and base of its anterior branch, and distal boundary of discal cell darker than veins elsewhere. *Squamae:* pale isabella-coloured. *Halteres:* stalks pale cream-buff, knobs dark brown or seal-brown surrounded by a narrow cream-buff band. *Legs:* coxae clothed chiefly with whitish hair, front pair sometimes also with brownish hair towards distal extremities, front and middle coxae greyish sepia-coloured, hind pair mouse-grey; femora, tibiae, and tarsi dark brown or dark sepia-coloured (front tarsi in both sexes, as also front femora and front tibiae in

♀, clove-brown), tibiae and middle and hind tarsi with pale markings as shown in fig. 2, hind tibiae in ♂ sometimes with a distinct indication of a second pale band, at least on inner side; bands on front tibiae, as also sometimes those on hind tibiae in ♀, waxen-white, other pale markings (bands on hind tibiae in ♂, and in both sexes bands on middle tibiae, proximal two-thirds or three-fourths of first joints of middle and hind tarsi, and bases of second and third joints of middle tarsi) cream-buff; front tibiae in ♀ slightly swollen beyond pale band; pale bands on front tibiae clothed with glistening cream-coloured hair, in ♀ pale bands on hind tibiae and proximal pale bands on middle tibiae clothed with glistening yellowish hair, similar short hairs sometimes also present on pale bands on middle and hind tibiae in ♂, otherwise hairy covering of femora, tibiae and tarsi in both sexes dark brown.

Sierra Leone Protectorate; Gold Goast (Northern Territories); Northern Nigeria. Type of ♂ and 6 para-types (2♂♂, 4♀♀) from Kalande, Northern Territories, Gold Coast, 22. vii. 1910, "at water-hole" (*Dr. F. J. A. Beringer, W.A.M.S.*); type of ♀ from swamp near Salaga, Tamale Road, Northern Territories, Gold Coast, 17. viii. 1910 (*Dr. F. J. A. Beringer*). The following are the localities and dates of capture of 15 additional examples of this species, which, like the types and para-types, were taken by Dr. Beringer in the Northern Territories, Gold Coast, in 1910, and were subsequently presented by him to the British Museum (Natural History):—Kwelo, 23. vii., "water side" (1 ♂); Kombi, 24. vii., "water side" (4 ♀♀); Salaga-Kunkwa Road, 29. vii. (2♀♀); yam farms near Jampaei (?), 29. vii. (7 ♂♂, 1 ♀). Sierra Leone Protectorate: one ♀ from "bush near Manunkon," 2. vii. 1913 (*Dr. J. Y. Wood, W.A.M.S.*:—presented to the National Collection by the Imperial Bureau of Entomology). Northern Nigeria (Ilorin Province): 2 ♂♂, 3 ♀♀ from Ilorin, 20. v., 16. viii. 1912, 1 ♀ from Afon, 29. v. 1912, 1 ♀ from Ariore, 22. vii. 1912, and 1 ♀ (precise locality and date of capture uncertain) from R. Aunwa, between Moma and Agodi (*Dr. J. W. Scott Macfie, W.A.M.S.*:—presented to the British Museum (Natural History) by the Imperial Bureau of Entomology).*

In the ♀ sex, at any rate, *Haematopota hastata* appears to show affinity to *H. decora*, Walk., to which it displays a distinct resemblance in the width of the front, shape and coloration of the frontal callus, shape of the antennae, and presence of a clove-brown transverse band on the face; in addition to the foregoing, further approximation between the two species is seen in the shape and size of the stigma in the wing, and of the dark blotch below it. *Haematopota decora*, however, is very different from *H. hastata* in general appearance, and is readily distinguishable from it by means of a number of characters, including the broader shape and pure white colour of the terminal joint of the palpi, the much greater development of the light grey markings on the dorsum of the thorax (the base of the scutellum in *H. decora* is conspicuously grey), the decidedly paler wings, in which the light markings are *milky-white* and much fused together

* The following specimens, also taken in Ilorin, Northern Nigeria, by Dr. Scott Macfie, are in the possession of the Imperial Bureau of Entomology: 1 ♂, 2 ♀♀ from Ilorin, 20, 23. v., and 28. vii. 1912; 1 ♀ from Afon, 29. v. 1912; and 1 ♂ and 1 ♀ from Ariore, 22. vii. 1912.

in the case of the proximal and distal rosettes, the much greater breadth and pure white colour of the bands on the front and hind tibiae, and the presence of conspicuous fringes of hair on the latter and on the front and hind femora. *Haematopota hastata* would appear to be somewhat more distantly allied to *H. vittata*, Lw. (syn. *H. pulchrithorax*, Austen), to which it presents an approximation in the shape and coloration of the frontal callus of the ♀, shape of the first and of the expanded portion of the third joint of the antennae, and presence of the dark band on the face. Apart from all other characters, however, the new species can at once be distinguished from *H. vittata* owing to the much greater depth of the terminal annuli of the antennae in *H. hastata*, and to the absence of the grey marking on the dorsum of the thorax that is characteristic of *H. vittata*.

The most noteworthy differences between *Haematopota hastata* and the following species, to which it is perhaps allied more nearly than to any of its African congeners yet described, are pointed out below.

Haematopota harpax, sp. n.

♀.—Length (3 specimens) 9·8 to 12 mm.; width of head (2 specimens) 3·4 to 3·6 mm.; width of front at vertex (2 specimens) 1·2 to 1·4 mm.; length of wing (2 specimens) 10·4 to 11 mm.

Moderately large, dark-coloured species, with dark sepia-coloured thorax and wings and dark brown abdomen; face with a clove-brown transverse band below antennae; antennae resembling those of foregoing species in shape, except that distal angles of second joint are even more conspicuous, being each produced into a long, thumb-shaped process; grey markings on dorsum of thorax and abdomen resembling those of foregoing species, but median stripe on third and following abdominal segments may be wanting; pale bands on front tibiae near base darker (cream-buff instead of waxen-white) and narrower than in H. hastata.

Head: drab-grey pollinose, face below clove-brown transverse band lighter; *front* of moderate and uniform breadth, not expanded anteriorly, with a large sepia-coloured patch between lateral frontal spots, and another, median and somewhat cordate patch of similar colour on vertex, extending to median frontal spot (when rubbed, front, except vertical angles and a narrow margin next each eye, may appear sepia-coloured); median and lateral clove-brown frontal spots conspicuous, lateral spots elongate, in contact with or narrowly separated from eyes; front sparsely clothed with short, dark brown hairs, face and jowls clothed with longer hair of same colour, basioccipital region clothed with whitish hair; clove-brown transverse band on face extending from eye to eye, clove-brown median spot above bases of antennae, and between latter and frontal callus, distinct; *frontal callus* mummy-brown, small, forming a narrow transverse band incompletely divided in middle line by a triangular pollinose prolongation from the front, and with its upper lateral angles rounded off, so that callus is narrowly separated from eye on each side; *palpi* dark, proximal joint and base of terminal joint greyish sepia-coloured, remainder of terminal joint clove-brown on outside, terminal joint elongate, moderately swollen towards base, clothed on outer side with short, appressed, black hairs, proximal joint and base of terminal

joint below clothed with longer brownish hair ; first joint of *antennae* dark sepia-coloured, greyish on inner side and on upper surface at base, moderately dull, cylindrical and strongly swollen, with its upper distal angle somewhat prominent ; second joint of antennae mummy-brown, the thumb-shaped processes mentioned in diagnosis above clove-brown ; third joint of antennae clove-brown, its shape (including that of the terminal annuli) agreeing with that of third joint of antennae in foregoing species (*see* fig. 2*a*), except that in profile upper margin of expanded portion is more convex in centre ; first joint of antennae clothed with short black or dark brown hairs, with longer hairs of same colour above and below ; thumb-like processes of second joint and upper and lower margins of expanded portion of third joint also bearing short black hairs. *Thorax* : median grey stripe on main portion of dorsum wanting (at least in case of type and para-type), but crescentic grey marks on hind border of main portion of dorsum each with a forwardly directed extension, runnng towards but not reaching admedian grey fleck behind transverse suture ; humeral calli and areas immediately behind them, and anterior extremities of admedian stripes light grey ; median stripe on scutellum smoke-grey ; dorsum sparsely clothed with short, yellowish hairs ; pleurae and pectus sepia-coloured, clothed with brownish hair (area above front coxae drab, clothed with paler hair). *Abdomen* : hind borders of dorsal scutes of second and following segments (sometimes excepting last two) smoke-grey, last three dorsal scutes each with a pair of grey admedian spots ; dorsum—except grey hind borders of scutes, which are clothed with pale yellowish hair—clothed with appressed dark brown hair ; dorsal scutes of first three segments each with a large, smoke-grey patch at each lateral extremity, these patches in case of second segment clothed with short, pale yellowish hairs ; venter dark brown, clothed with short, appressed, similarly coloured hair. *Wings* : pale markings cream-buff, coarser, sparser, and less complex than in foregoing species, the rosettes, which are well developed, not consisting of more than two or portions of two rings in each case ; portion of proximal rosette between discal cell and second longitudinal vein largely coalesced, consisting of two relatively coarse, curved, pale marks at base of first submarginal cell, two others at base of first posterior cell, and two more at distal extremity of first basal cell ; this portion of each wing consequently appears paler than in *H. hastata* ; pale mark in marginal cell immediately beyond stigma small (at least in type and para-type), sharply defined, and separated by a wide interval from further margin of distal rosette ; apical sinuous mark well developed, not double ; distal marginal angles of posterior cells occupied by pale blotches, which vary in size and are sometimes very small and inconspicuous ; light markings in anal and axillary cells resembling those in *H. hastata* (*see* fig. 2) ; *stigma* dark brown, elongate, with beneath it a large, quadrate, dark brown blotch, which is darker than remainder of wing ; veins dark brown, infuscated portions as in *H. hastata*, but more pronounced. *Squamae* light drab or isabella-coloured. *Halteres* : knobs clove-brown, stalks cream-buff. *Legs* : dark sepia-coloured, dark brown, or clove-brown, front tibiae each with a single narrow pale band near base, middle and hind tibiae each with two pale (buff-coloured) bands, first joints of middle and hind tarsi except tips (distal fourth or distal third) also pale

(cream-buff); pale bands on tibiae clothed with short, glistening, ochreous hair, front tibiae sometimes with an indication (faintly marked but clothed anteriorly with a few glistening ochreous hairs) of a second pale band towards distal extremity; hind coxae clothed below with pale yellowish hair; legs except as stated, clothed with short, dark brown hair; front tibiae slightly thickened beyond pale band, but neither front nor hind tibiae really incrassate.

BELGIAN CONGO: type from R. Congo, opposite Coquilhatville, 1. x. 1910 (*Dr. A. Yale Massey**); a second specimen (para-type) from Bolombo, R. Congo, 8. x. 1910 (*Dr. J. Bequaert*:—in the Musée du Congo Belge, Tervueren, Belgium). A third ♀ of this species, from Lisala, R. Congo, 22. iii. 1909 (—*Waelbroeck*), is in the collection of the Musée National D'Histoire Naturelle, Paris.

As indicated at the end of the description of the foregoing species, *Haematopota harpax* is closely allied to *H. hastata*, the points of difference from which have already been alluded to above. Shortly stated, *Haematopota harpax* is distinguishable from *H. hastata* by its darker palpi, by the first joint of its antennae being less shining, by the distal angles of the second joint of its antennae being produced into thumb-shaped processes, by the pale wing-markings being coarser, sparser, and less complex, and by the hind tibiae having a second pale band.

Haematopota maculosifacies, sp. n. (fig. 3).

♀.—Length (9 specimens) just over 7 to 8·4 mm.; width of head 2·75 to just over 3 mm.; width of front at vertex 1 to just over 1 mm.; length of wing 6·4 to 7 mm.

Small blackish species, with slender, elongate antennae, and on the face, below the latter, a transverse row of four sharply defined, clove-brown spots.—Front relatively broad, and broader below than on vertex; dorsum of thorax olive-brown, with grey markings not very extensive nor conspicuous; dorsum of abdomen blackish clove-brown (darker than thorax), with grey markings as shown in fig 3; *wings mouse-grey or light sepia-coloured, with clearly defined pale markings as shown in* fig. 3, *usual apical sinuous mark appearing as a nearly straight transverse band.*

Head: light grey pollinose, *front* except extreme lateral margins and a narrow ring surrounding each lateral frontal spot, darker, vertex with an olive-brown blotch narrowly divided in middle line by a fine grey or cinereous stripe which extends to median frontal spot; all three frontal spots present, median spot very small and inconspicuous, lateral frontal spots large, rounded, not in contact with eyes; front above callus sparsely clothed with short, yellowish hair, and clothed on vertex with dark brown hair; *frontal callus* a shining black transverse band of moderate depth, extending from eye to eye, its upper margin usually rising in middle line to a more or less well-marked angle; a single, well developed, quadrate, clove-brown spot in middle line, below frontal callus (with lower margin of which it is in contact) and between bases of antennae; face, jowls, and basioccipital region clothed with glistening whitish hair; in the *transverse row of*

* Writing to the author from Coquilhatville, on 26. xi. 1910, with reference to this specimen, Dr. Yale Massey said: "This is the only *Haematopota* met with so far. The wet season has now set in, but these flies do not seem to be here as yet."

four clove-brown spots on the face, the spot at each end of the row is in contact with or only narrowly separated from the eye on that side, while each of the remaining spots is directly below one of the antennae ; *palpi* mouse-grey, clothed with glistening pale yellowish hairs, which on outer side of terminal joint are interspersed with short black hairs, terminal joint of palpi elongate, moderately swollen towards base and bluntly pointed at distal extremity; first joint of *antennae* (*see* fig 3a) five-sixths of a millimetre in length, cylindrical and not at all swollen, isabella-coloured at base and usually darker (mouse-grey or brownish-grey) towards distal extremity, and clothed on outer side and above with minute blackish hairs ; second joint of antennae small, mummy-brown clothed with minute blackish hairs and with neither of its angles noticeably produced ; third joint of antennae narrow and elongate, proximal portion dark brown (usually

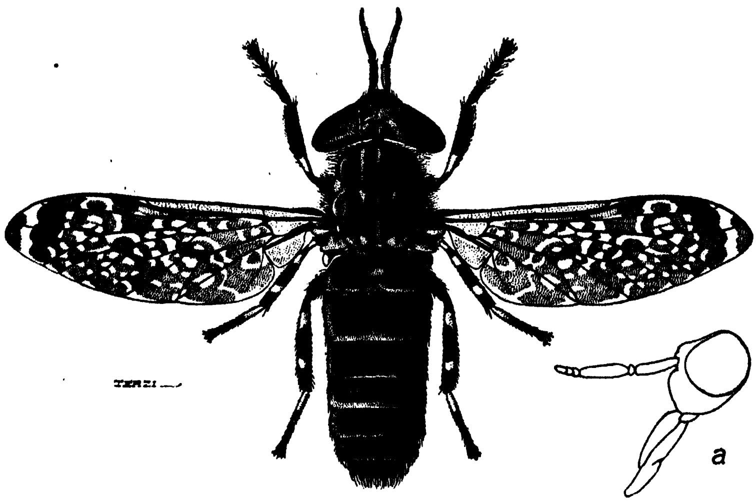


Fig. 3.—*Haematopota maculosifacies*, Austen, ♀. × 6.

mummy-brown at base), terminal annuli clove-brown, total length of third joint, including terminal annuli, from one-fourth to one-half greater than that of first two joints taken together. *Thorax :* dorsum with a narrow, grey, median longitudinal stripe (sometimes obliterated in centre) extending from front margin to praescutellar groove ; on each side of middle line a slightly broader grey longitudinal stripe extends from front margin of dorsum nearly to inner extremity of lateral portion of transverse suture, where it terminates ; hind margin of main portion of dorsum with the usual grey crescentic marks, and inner extremities of lateral portions of transverse suture each ending in a grey, deltoid spot ; in addition to grey markings just described, the humeral calli, lateral borders of main portion of dorsum, and hind border of scutellum are grey, and behind transverse suture is a grey longitudinal stripe on each side, extending from suture nearly to outer extremity of corresponding crescentic mark ; dorsum sparsely clothed with minute, appressed, glistening Naples-yellow hairs ; pleurae and pectus light grey, clothed with whitish hair. *Abdomen:* lateral borders and hind margins of tergites of all segments grey, anterior margin of tergite of second

segment also more or less grey, tergites of fourth (or third) and following segments each with a pair of grey, admedian spots (sometimes difficult to distinguish), grey hind margin of tergite of second segment often produced in middle line into a forwardly directed triangle, third (or fourth) to sixth tergites inclusive usually each with a grey median longitudinal stripe or more or less distinct vestige thereof; clove-brown area of dorsum clothed with minute, appressed hairs of similar colour, grey lateral borders and posterior angles of dorsal scutes clothed with glistening whitish hair; venter smoke-grey, hind margins of ventral scutes of second and following segments paler, ventral scute of last segment and also an ill-defined area in centre of ventral scutes of penultimate and antepenultimate segments (except hind margin in each case) darker (mouse-grey or brownish grey), at least when viewed from certain angles; venter, except last segment, clothed with minute, appressed, yellowish-white hairs, ventral scute of last segment clothed with erect blackish hair. *Wings:* all three rosettes well defined, not compound, their distal margins usually broken up into dots; *stigma* dark mummy-brown, moderately elongate, sharply defined and much darker than ground colour of wing, with no quadrate dark blotch below it, proximal extremity of stigma pale; transverse band at apex of wing (mentioned in diagnosis above) very conspicuous; posterior cells, except fourth, each with a large pale blotch occupying distal marginal angle, corresponding blotch in fourth posterior cell wanting or much smaller; veins mummy-brown, the usual local infuscations not very noticeable. *Squamae* colourless. *Halteres:* stalk cream-coloured, darker (usually more or less seal-brown) at base, knobs cream-buff, seal-brown at extreme base above and below. *Legs:* coxae grey, clothed with whitish hair, front coxae often clove-brown except proximinal half or two-thirds of anterior surface, and with some minute black hairs in front near distal extremity; femora clove-brown, more or less greyish pollinose, clothed partly with minute black hairs and partly with yellowish or whitish hair; front tibiae clove-brown or blackish clove-brown, distinctly incrassate beyond proximal third, middle and hind tibiae dark brown, hind pair somewhat thickened, front tibiae with a single narrow, cream-coloured band just beyond base, middle and hind tibiae each with two cream or cream-buff-coloured bands as shown in fig. 3, tibiae except pale bands clothed with short blackish or dark brown hair, pale tibial bands clothed with minute, glistening, cream-coloured hairs, which on hind tibiae are usually also present to some extent on interspace between bands, front tibiae often with a few similar hairs on outer side midway between pale band and distal extremity; front tarsi black, middle and hind tarsi clove-brown, proximal three-fourths or two-thirds of first joint of middle and hind tarsi cream-coloured, second and third joints of hind tarsi sometimes narrowly cream-buff at extreme base.

GERMAN EAST AFRICA: South Usagara, 22. xii. 1910 (*S. A. Neave*). Type and six para-types presented to the National Collection by the Imperial Bureau of Entomology (two other para-types, collected by *Mr. S. A. Neave* at the same time and place as the other specimens, remain in the possession of the Bureau).

At first sight *Haematopota maculosifacies* presents a certain resemblance to *H. cruenta*, Austen, and *H. crudelis*, Austen (*Bull. Ent. Res.*, iii, part 3,

December 1912, p. 414, fig. 4), the latter of which also occurs in German East Africa and in the same locality as the species just described. Apart from all other points of difference, however, *Haematopota maculosifacies* can at once be distinguished from the two species mentioned owing to the slender and elongate shape of its antennae.

Haematopota ingluviosa, sp. n. (fig. 4).

♀.—Length (12 specimens) 9·6 to 12 mm.; width of head 3 to 4 mm.; width of front at vertex 0·8 to just over 1 mm.; length of wing 8 to 9·6 mm.

Medium-sized to fairly large, dark sepia-coloured, dark brown or mummy-brown, bulky-bodied species, with short antennae, a pair of sharply defined and conspicuous grey spots on dorsal surface of each abdominal segment, as shown in fig. 4, *and palish wings in which the stigma is usually conspicuous.*

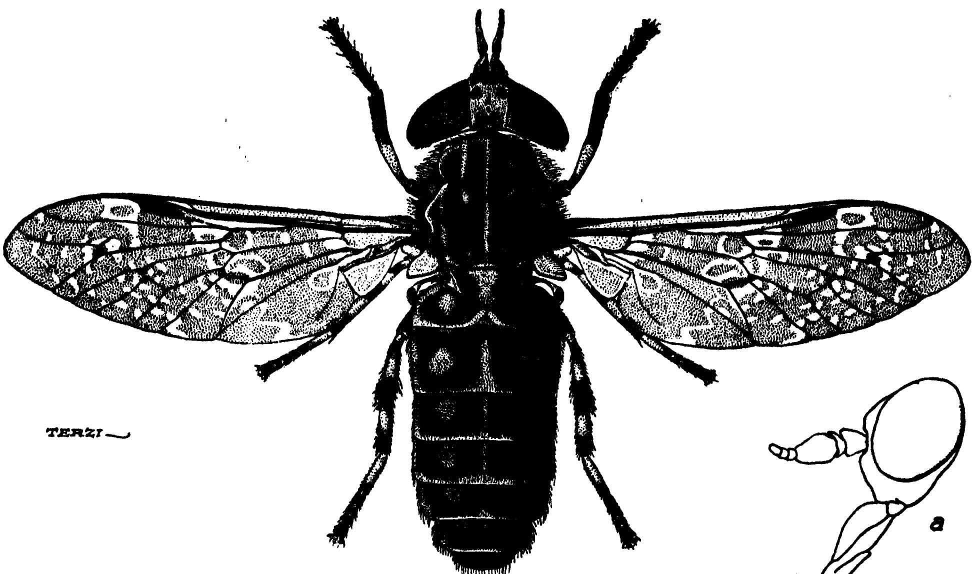


Fig. 4.—*Haematopota ingluviosa*, Austen, ♀. × 6.

Head: front narrow and of nearly uniform width, mouse-grey or brownish (a small area on each side of vertex and a narrow ring surrounding each lateral frontal spot yellowish-grey or light grey); usual darker patch on vertex, divided in middle line by a narrow grey stripe running to median frontal spot, sometimes distinguishable; median frontal spot present but often inconspicuous, lateral frontal spots in contact with eyes; front on each side immediately above callus and on vertical angles clothed with minute yellowish hairs, elsewhere clothed with minute dark brown hairs; *frontal callus* raw-umber-coloured, often darker in centre, moderately deep from above downwards, extending from eye to eye, its lower edge straight, its upper angles rounded off, and its upper margin sometimes rising to an angle in middle line; a small, clove-brown, partially bifid, median spot below frontal callus (with lower edge of which it is in contact) and above bases of antennae; face,

jowls, and basioccipital region light grey pollinose, clothed with whitish hair, upper part of face on each side usually with an ill-defined mummy-brown area between antenna and eye, and lower down with a short, transversely elongate, similarly coloured spot resting on eye ; *palpi* light isabella-coloured, proximal joint and base of distal joint above and below clothed with whitish hair, remainder of outer surface of distal joint clothed with minute black hairs ; *antennae* shaped in profile as shown in fig. 4a, first two joints raw-umber-coloured, clothed with minute black hairs, third joint mummy-brown, expanded portion occasionally paler (raw-umber-coloured), first joint somewhat swollen. *Thorax:* dorsum with grey markings as shown in fig. 4, and sparsely clothed with minute, appressed, yellowish hairs ; pleurae and pectus smoke-grey, clothed with whitish hair. *Abdomen:* dorsum sometimes with a cinnamon-rufous tinge, sometimes of same colour as or darker than dorsum of thorax ; grey dorsal markings as shown in fig. 4, spots on first four segments rounded, those on remainder or at least on last two segments elongate ; dorsum clothed on sides with whitish hair, and on dark portion of surface with minute, appressed, dark brown hairs ; venter greyish pollinose (central portion of last two segments darker), clothed for most part with minute, appressed, yellowish hairs, hind margins of all ventral scutes except first and last more or less cream-buff, hair on last segment and on dark area on penultimate segment dark brown. *Wings:* drab-coloured, with light markings as shown in fig. 4 ; *stigma* dark mummy-brown (occasionally lighter brown), with no quadrate dark blotch below it, proximal extremity of stigma pale ; veins for most part dark mummy-brown, local infuscations inconspicuous. *Squamae* waxen-greyish, their borders cream-coloured. *Halteres* : stalks cream-coloured, seal-brownish at base, knobs seal-brown, outer margins cream-buff or cream-coloured. *Legs:* coxae clothed with whitish hair, front pair, drab-grey, middle and hind pairs grey ; femora greyish-cinnamon or greyish fawn-coloured, pollinose, clothed for most part with yellowish or whitish hair, but with black hairs at distal extremities at least on inner side, front femora often largely dark brown on anterior surface ; tibiae marked as shown in fig. 4, front tibiae clove-brown, somewhat incrassate beyond proximal third, seal-brown at extreme base, beyond which is a fairly broad cream-buff band clothed with minute, appressed, glistening cream-coloured hairs ; middle and hind tibiae dark brown, each bearing two narrower cream-buff bands and with their extreme bases also pale ; front tarsi clove-brown ; middle and hind tarsi dark brown, first joint of each, except distal extremity, and three following joints of hind tarsi at extreme base cream-buff.

SOUTHERN RHODESIA ; NORTHERN (NORTH - WESTERN) RHODESIA. Type and nine para-types from Mt. Chirinda, Melsetter District, Southern Rhodesia, alt. 3,800 ft., 11–15. x. 1911, and to additional specimens from Chirinda Forest, 60 miles south of Melsetter, alt. 3,800 ft., 1. x. 1909 (*C. F. M. Swynnerton* :—presented to the British Museum (Natural History) by the Imperial Bureau of Entomology). NORTHERN RHODESIA : one specimen from Chilanga, North-Western Rhodesia, alt. 4,030 ft., 3. x. 1913 (*R. C. Wood:* presented to the British Museum (Natural History) by the Imperial Bureau of Entomology).

Haematopota ingluviosa belongs to a group of species which includes among others, ***H. sanguinaria***, Austen (Northern Rhodesia), ***H. edax***, sp. n. (Uganda,—

see below), and a fourth species, at present undescribed, of which specimens have been received from the East Africa Proctectorate by the British Museum (Natural History) and the Imperial Bureau of Entomology.* From *Haematopota sanguinaria* the species just described is distinguishable, at least in the female sex, by reason of its larger size and generally darker coloration, and further by the third joint of its antennae being brown instead of tawny-ochraceous, by the distal portion of its scutellum not being ochraceous-buff and by the stigma being much darker. From the female of *Haematopota edax* that of *H. ingluviosa* may be distinguished owing to its paler frontal callus, and to the much less elongate shape of the expanded portion of the third joint of its antennae. The undescribed *Haematopota* from the East Africa Protectorate mentioned above is closely allied to *H. ingluviosa*, to which, in the female sex at any rate, it presents a deceptive resemblance, agreeing with it in size and general appearance. The East African species is however distinguishable from that described above owing to the first and third joints of its antennae being somewhat more elongate, to the pale markings of the wings being less distinct, and to the distal portion of the front tibiae being slightly less thickened and not so dark, *i.e.*, brown instead of clove-brown.

Haematopota edax, sp. n.

♀.—Length (6 specimens) 9·4 to 10·5 mm.; width of head 3 to 3·4 mm.; width of front at vertex 0·8 to 1 mm.; length of wing 8·2 to 9 mm.

In general appearance closely resembling smaller and paler specimens of foregoing species, but distinguishable owing to greater length of antennae, due to more elongate and tapering shape of expanded portion of third joint (as viewed from side).—Front narrow and of nearly uniform width (usually appearing narrower than in foregoing species), frontal callus dark brown; dorsum of thorax sepia-coloured, with grey or yellowish-grey markings as in foregoing species; abdomen tapering to distal extremity, dorsum mummy-brown with yellowish-grey markings exactly like the grey abdominal markings in foregoing species (see fig. 4); *wings light sepia-coloured, stigma dark brown, elongate and distinct; front tibiae clove-brown, with a single pale band as in foregoing species.*

Head: front sepia-coloured, lateral margins and expansions from them surrounding lateral frontal spots yellowish grey, usual dark patch on vertex also often triangular in outline owing to a yellowish-grey border, the two sides of which run inwards and forwards till they meet in front of median frontal spot, while patch itself is divided by a narrow grey median stripe; median frontal spot usually indistinguishable, lateral frontal spots small, in contact with eyes; front clothed on sepia-coloured area with minute black or dark brown hairs, and on yellowish-grey area between each lateral frontal spot and callus clothed with pale-yellowish hairs: *frontal callus* extending from eye to eye, moderately deep and shaped as in foregoing species; median clove-brown spot below callus, small but distinct, usually almost divided into two by a triangular indentation in its

* Also belonging to this group are *Haematopota* (*Parhaematopota*) *cognata*, Grünb., and a new species found, like the latter, in German East Africa; both of these, however, are at once distinguishable from the species mentioned above owing to the presence of a second pale band on the front tibiae.

lower margin; face, jowls, and basioccipital region yellowish-grey pollinose, fairly thickly clothed with pale-yellowish hair, region between antenna and eye on each side sometimes minutely speckled with mummy-brown; *palpi* light isabella-coloured, outer surface of terminal joint towards distal extremity sometimes with a darker tinge, proximal joint and base of terminal joint below clothed with pale yellowish hair, outer surface of terminal joint clothed with minute black hairs; first two joints of *antennae* as in foregoing species, except that first joint is perhaps slightly less swollen, third joint mummy-brown or sepia-coloured (expanded portion sometimes paler at base and terminal annulus often dark brown or clove-brown), expanded portion of third joint viewed from side cuneate, being deep just beyond base and thence tapering gradually to distal extremity. *Thorax:* dorsum sparsely clothed with minute, appressed, yellowish hairs, swelling on each side between bifurcations of transverse suture clothed, except above, with outstanding dark brown or blackish hair; pleurae and pectus smoke-grey, clothed with yellowish-white hair. *Abdomen:* mummy-brown area of dorsum clothed with short, appressed hair of same colour; venter, except last two segments, light drab-grey pollinose, ventral scutes of last two segments smoke-grey, hind margins of ventral scutes of all segments except last cream-buff, ventral scutes of second to fourth segments inclusive clothed with minute, appressed, yellowish hairs, ventral scutes of penultimate and antepenultimate segments clothed with longer and more erect dark brown hair. *Wings:* agreeing closely with those of foregoing species as regards both coloration and markings (*cf.* fig. 4); pale loop in marginal cell beyond stigma small or even reduced to a spot, apical sinuous mark indistinct or obsolete in middle of second submarginal cell, otherwise distinct. *Squamae* light drab. *Halteres:* stalks cream-coloured, seal-brownish at base, knobs seal-brown, with a narrower or broader cream-buff outer edge. *Legs:* as in foregoing species.

UGANDA PROTECTORATE: presented to the British Museum (Natural History) by Surgeon-General Sir David Bruce, C.B., F.R.S., A.M.S.

For notes on the affinities of *Haematopota edax* reference should be made to the concluding paragraph of the description of the foregoing species.

Haematopota nigripennis, sp. n. (fig. 5).

♀.—Length (4 specimens) 10·75 to 12 mm.; width of head 4 to nearly 4·5 mm.; width of front at vertex 1·4 mm.; length of wing 9·4 to 10·5 mm.

Medium-sized to moderately large, black or blackish species, with wide head and long antennae, of which the first joint is characteristically swollen, while the third joint is elongate and attenuate. Wings and dorsum of thorax clove-brown, with sharply defined milk-white and light grey markings respectively, as shown in fig. 5; *dorsum of abdomen shining black (first two segments clove-brown), hind border of each segment cinereous or grey; legs mainly black, tibiae and middle and hind tarsi with milk-white or cream-coloured bands, as shown in* fig. 5.

Head: ***front*** **fairly broad and broader below than at vertex, clove-brown, with light grey markings along each side and a duller grey mark next to inner extremity of each lateral frontal spot, as shown in fig. 5; median frontal spot distinct, often exhibiting a short transverse black mark above actual spot, lateral**

frontal spots very large and conspicuous, in contact with eyes and also extending downwards till they meet frontal callus; lateral frontal spots and clove-brown area of front clothed with short, erect, clove-brown hair, a few whitish hairs on each side on grey spot between frontal callus and lateral frontal spot; *frontal callus* a shining black transverse band of moderate depth, extending from eye to eye and protuberant on each side of middle line; a fairly large, dull black, median spot, narrowly divided in middle line, in contact with lower margin of callus and between it and bases of antennae; face, jowls, and basioccipital region light grey pollinose, clothed with whitish hair, upper part of face on each side with a dark-brown-haired, transversely elongate, clove-brown spot between eye

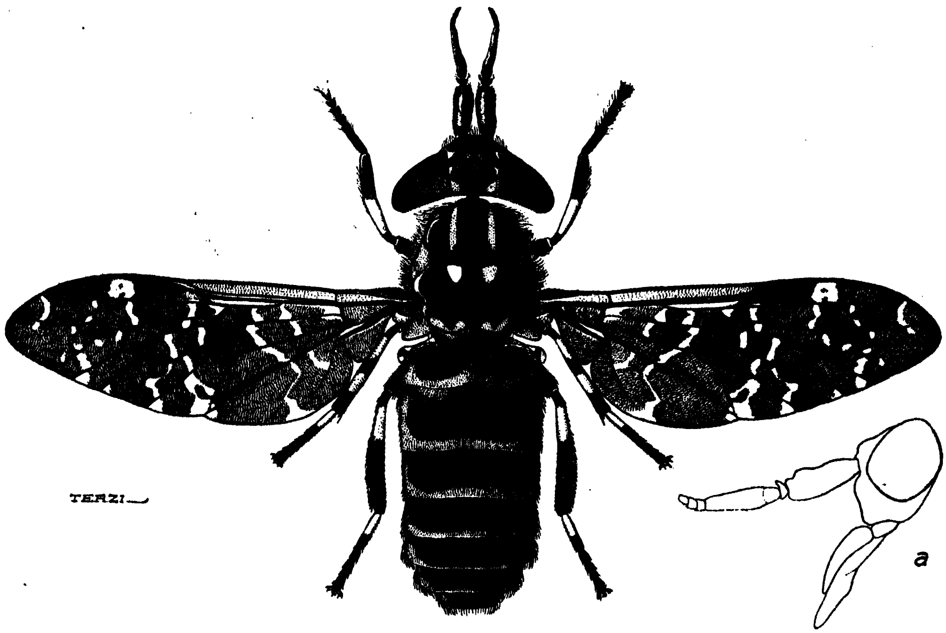


Fig. 5.—*Haematopota nigripennis*, Austen, ♀. × 5.

and antennae, and a little lower down a similar but smaller spot resting on inner margin of eye; *palpi* (*see* fig. 5a) grey, proximal joint and proximal half or two-thirds of lower border of terminal joint clothed with whitish hair, remainder of outer surface of terminal joint clothed with minute black hairs, sometimes intermixed with minute whitish hairs; first joint of *antennae* (*see* fig. 5 and fig. 5a) shining black, thinly greyish pollinose, elongate and strongly swollen, roughly elliptical in outline when viewed from above, but when viewed from the side its upper margin, as seen in fig. 5a, exhibits two depressions, one in centre, the other close to distal extremity; second and third joints of antennae clove-brown (terminal annuli of third joint black), shaped as shown in fig. 5 and fig. 5a; first and second joints of antennae clothed with short black hair, proximal two-thirds of lower inner margin of first joint clothed with long whitish hair. *Thorax:* narrow, median, longitudinal stripe on dorsum drab-grey, usually becoming obsolete (in pinned specimens at any rate) about level of large light

grey spots behind transverse suture; swelling occupying triangular depression at each end of transverse suture drab-grey, clothed with outstanding dark brown hair, mixed with glistening whitish hair along posterior margin; clove-brown area of dorsum sparsely clothed with hair of same colour as ground, postalar calli and grey mark on each side above base of wing clothed with whitish hair; pleurae and pectus light grey, clothed with whitish hair. *Abdomen:* lateral extremities of dorsal scutes of first two segments grey; dark area of dorsum clothed with short, appressed, clove-brown hair, lateral extremities of dorsal scutes of first five segments clothed with whitish hair; venter light grey pollinose (last segment, except its hind border, black and clothed as usual with coarse, erect, black hair), ventral scutes of second to sixth segments inclusive each with a large, dark-haired, median blotch resting on base but not quite reaching hind margin, grey area of venter clothed with short, appressed, whitish hair. *Wings:* light markings, as shown in fig. 5, much reduced, but nevertheless recognisable as remains of usual three rosettes; apical sinuous mark disappearing in second submarginal cell, near anterior branch of third longitudinal vein; *stigma* clove-brown, elongate, dark blotch below it not darker than remainder of dark area of wing. *Squamae* dusky, their borders clove-brown. *Halteres:* cream-coloured, knobs with a clove-brown or dark seal-brown patch at base above and below, leaving outer border as well as distal extremity cream-coloured. *Legs:* coxae grey, clothed with whitish hair, distal extremities of front pair clove-brown or greyish clove-brown, clothed, at least in front, with blackish hair; front femora greyish pollinose on posterior and inferior surfaces, middle and hind femora greyish pollinose except distal extremities (median portion of greyish area of middle femora sometimes greyish fawn-coloured), all femora clothed with whitish hair on greyish area and with black hair elsewhere, distal extremities of hind femora distinctly fringed with black hair below; front tibiae slightly thickened beyond middle, front and hind tibiae each with a single, fairly deep, milk-white band just beyond base, middle tibiae each with two bands, milk-white tibial bands clothed with glistening whitish hair, tibiae clothed elsewhere with black hair (hind tibiae on anterior surface midway between band and distal extremity also with a few glistening whitish hairs), hind tibiae on outer surface with a fairly long and dense fringe of black hair, commencing on distal third of milk-white band, where it is at its longest, and becoming gradually shorter until it reaches the tip; first joint of middle and hind tarsi with a cream-coloured, black-haired band occupying proximal half.

Uganda Protectorate: type and two para-types from Lake George, "in forest," 20. ii. 1913 (*Dr. C. H. Marshall*); a third para-type from Entebbe, 22. viii. 1912 (*C. C. Gowdey*):—presented to the National Collection by the Imperial Bureau of Entomology.

This striking species is closely allied to *Holcoceria nobilis*, Grünb. (*Zoologischer Anzeiger*, xxx., no. 11/12, 3rd July 1906, p. 358, figs. 10 and 11), which is known to occur in German East Africa, the Nyasaland Protectorate, and Southern Rhodesia. In the shape of the antennae, as indeed in all other cephalic characters, as well as in all those exhibited by the legs, the two species are in absolute agreement. Grünberg's species can, however, at once be distinguished

from that described above owing to conspicuous differences in the marking of the thorax, abdomen, and wings. In *Holcoceria nobilis*, which is often considerably larger than the specimens of *Haematopota nigripennis* at present available for comparison, the markings of the dorsum of the thorax, instead of agreeing with those shown in fig. 5, consist simply of two continuous and converging light grey longitudinal stripes, which run without a break from the front margin to the praesutural furrow; in *H. nobilis*, too, the dorsum of the black abdomen is entirely devoid of grey transverse bands, but is uniformly covered with a thin greyish bloom, beneath which a trace of paired grey spots is sometimes visible when the abdomen is viewed at a low angle from behind; and lastly, in the same species the clove-brown wings are entirely unicolorous, with the exception of a milk-white transverse band just before the tip. There are no structural differences to separate *Holcoceria*, Grünb. (*loc. cit.*, p. 357,—founded for *H. nobilis*, Grünb.), from *Haematopota*, Mg., and, remarkable though it be that there should exist a *Haematopota* without the well-known characteristic wing markings, the discovery of the species described above renders it impossible any longer to maintain the generic distinctness of *Holcoceria*, so that *Holcoceria nobilis*, Grünb., must henceforth be assigned to *Haematopota*, and the genus *Holcoceria* must be abolished.

NOTES ON SCALE-INSECTS (COCCIDAE). PART II.

By Professor R. Newstead, F.R.S., &c.

The Liverpool School of Tropical Medicine.

This paper deals with a number of Coccids which have been forwarded through the Imperial Bureau of Entomology from the following countries: The Dutch West Indies, Barbados, British Guiana, Zanzibar, Uganda, Nyasaland, and Nigeria. Five species are herein described as new to science, the others, for the most part, are well-known pests affecting cultivated plants in various parts of the world.

Icerya maxima, sp. n.

Female adult (fig. 1).—Dorsum covered with striated lamellae of white wax; those in front relatively small and irregularly conchoidal in shape; median row much the smallest; submedian row very broad, curved outwards, and very thin; marginal series of great length, ribbon-like and curled. Ovisac formed beneath the abdomen by a complete pellicle of closely-felted secretion which is attached to the sides of body only, thus a narrow space is formed between the pellicle

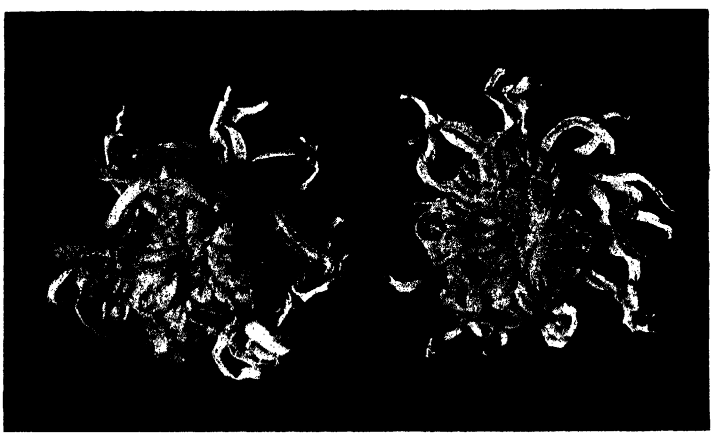


Fig. 1.—*Icerya maxima*, Newst., ♀♀, nat. size.

and the abdomen for the reception of the ova. Antennae (fig. 2*a*) of 11 segments of which the 2nd and the 11th are the longest; all the segments with fine hairs, a few of those on the 8th to the 11th, inclusive, much longer than the rest. Spinnerets (fig. 2*b*) very abundant on the dorsal integument, but less so on the venter. Legs normal and very stout. Stigmata nearly as large as the coxae and very strongly chitinised. Rostrum provided with a long membranous tube, down which the loop of the filaments pass (?) when in repose or when partly or wholly retracted. Marginal hairs relatively short and slender.

Length, exclusive of marginal appendages, 18–21 mm.; width 13–17 mm. The longest marginal appendage may measure as much as 15 mm.

Larva : Antennae (fig. 2*c*) of 6 segments, the 4th to 6th with exceedingly long hairs, the longest being about twice the length of the antenna ; so far as one can ascertain, there are at least 6 of these long hairs on the terminal segment, and 3 on the 4th and 5th respectively. Marginal hairs on the abdomen of similar length to those on the antennae, but stouter, and there are about twenty on either side ; the exact number must, however, remain in doubt, as the specimens have not restored at all well in the process of mounting for examination.

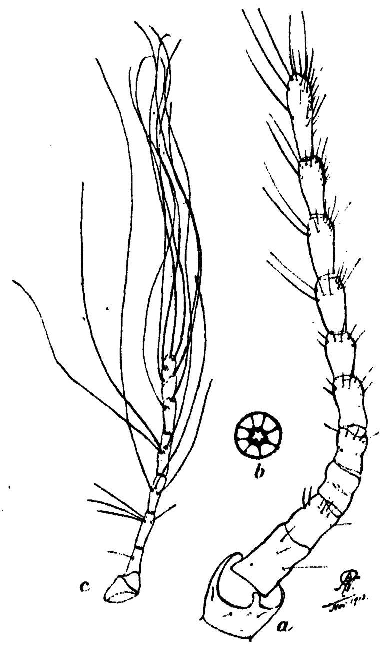


Fig. 2.—*Icerya maxima*, Newst. ; *a*, antenna of ♀ ; *b*, spinneret of ♀ ; *c*, antenna of larva.

GOLD COAST : Kwanyako, Winneba district, 16. xi. 13, on *Ficus* sp. (*W. H. Patterson*).

This is much the largest species of *Icerya* known to me, and apart from its great size is distinguishable by the enormous length of the thin ribbon-like waxen appendages to the margin of the body.

The larva, though it resembles that of *Icerya longisetosa*, Newst., is distinguished by the larger number of long hairs on both the abdomen and antennae.

Icerya seychellarum (Westwood).

UGANDA : Entebbe, 24. vi. 12, on *Monodora myristica* (*C. C. Gowdey*). NYASALAND : Mlanje, 22. iii. 13 (*S. A. Neave*).

This rather pretty little insect seems to be widely distributed, having been recorded from the Seychelles Islands, Madagascar, Mauritius, Madeira, China Formosa and New Zealand. Signoret's examples were found on sugar-cane, but it is apparently a somewhat general feeder, attacking such other plants as guava, palms, rose, citrus, *Artocarpus integrifolia*, etc.

Icerya sp.

UGANDA: Entebbe, 20. viii. 12, on orange (*C. C. Gowdey*, no. 4336).

All the leaves submitted were heavily infested with young females. It is just possible that this insect may prove to be Douglas' *Icerya* (*Ortonia*) *natalensis*, but it will be necessary to secure old adults in order that a correct specific determination may be given. Douglas unfortunately did not describe the immature females and I know of no recent account of the younger stages of this insect in the literature of the COCCIDAE.

Aspidoproctus giganteus, sp. n.

Female adult, when perfect, completely covered with a thin, compact coating of dusky grey secretion; the secretionary matter is, however, frequently worn away, either partly or entirely so, revealing the dark castaneous chitin beneath. Dorsum with a large, double, mammiform projection, which arises at the junction of the abdomen with the thorax; abdominal area with a submarginal series of tubercular projections, often but faintly indicated; margin with short, broad and often bifid waxen appendages. Antennae (fig. 3*a*), very short, stout, being

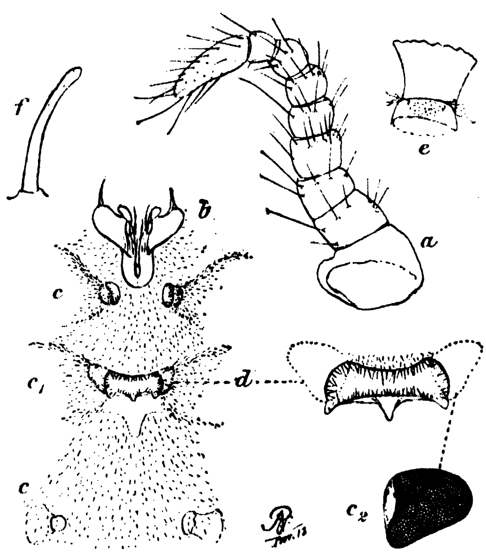


Fig. 3.—*Aspidoproctus giganteus*, Newst., ♀; *a*, antenna; *b*, mentum; *c*–*c*₂, large sternal glands; *d*, mesal compound glands; *e*, circular gland; *f*, spine.

approximately of the same length as the tibia of the posterior leg, and composed of 9 segments, of which the terminal one is nearly three times the length of the 8th; 5th-8th inclusive, more or less bead-like; all the segments with fine hairs. Legs short and stout; tarsus, inclusive of the claw, half the length of the tibia. Mentum (fig. 3*b*) monomerous and relatively very small for so large a species. Immediately below the mentum are three pairs of very large glands (fig. 3*c*, *d*), each one of the upper or proximal and the lower or distal pairs opening into a large and somewhat cylindrical chamber; the second pair (fig. 3c_1) communicates

with a single rectangular chamber (fig. 3*d*), the distal lip of which has three angular projections; at the base of each of the glands a group of minute pores (fig. 3c_2) which collectively present a reticulated appearance; the first two pairs have relatively huge subcutaneous sclerites. In addition to the large paired glands are many others (fig. 3*e*) of a smaller size and with dilated subcutaneous tubes. Integument of the dorsum almost covered with minute and rather bluntly pointed spines; numerous minute circular spinnerets and large glands, apparently of a similar form to the smaller ones found on the venter—the density of the chitin renders these organs somewhat obscure. Margin of large ventral orifice (? anal orifice or marsupium) with a broad band of densely packed and minute spinnerets. Marginal spines (fig. 3*f*) straight or slightly curved and slightly dilated; in the midst of these spines at somewhat regular intervals are well-defined groups of fine hairs, about four times the length of the spines.

Length 20–25 mm.; width 16–20 mm.; height 10–13 mm.

SOUTHERN NIGERIA: Ibadan, 7. vi. 13, on Silk Cotton Tree (*Ceiba bombax*) (*Dr. W. A. Lamborn*).

Dr. Lamborn sends the following information regarding this insect:—"Coccids from branches of a fallen cotton tree, I think *Ceiba bombax*, the leaf and seed of which are now sent. The tree, which is known as the African Fetish Tree, is about our largest forest tree, being I should estimate often 130 to 140 feet in height and of enormous girth. The insects were first seen on 7th June 1913 here and there, by no means numerous and never more than two together, on the under side only of boughs averaging 7 or 8 inches in diameter. Branches larger than these were unaffected.

"The height from the ground of the affected boughs was, by tape measure, between 98 and 104 feet. The bark on them was about $\frac{1}{6}$ inch in thickness and on stripping it off one found in many cases on the light yellow surface exposed under them a dark brown discoloration about the size of a 3*d.* piece.

"The insects being grey in colour harmonised well with the bark. Many were quite dead and had cracked open when the tree fell so as to expose an enormous number of tiny cheese-coloured ovoid eggs. Many of the boughs had holes, evidently made by borers of some sort, and on splitting them open, cavities were found tenanted by other Coccids. Two of these which were the size of a large pea were black, and the others which were very numerous were minute and flesh-coloured."

This remarkable Coccid somewhat resembles *Aspidoproctus pertinax*, Newst., but may at once be distinguished by its markedly greater dimensions, the presence of the double mammiform process in the middle of the dorsum; and also in having eight instead of nine segments to the antennae.

Lindinger* has sunk *Aspidoproctus*, Newst., under the genus *Lophococcus*, Ckll.,† but leaves us still in doubt as to whether they are congeneric or not.

I had already stated‡ that the former may have to sink as a synonym of the latter; but that it remains with Cockerell to decide as to whether his *Lophococcus*

* Jahr. der. Hamb. Wiss. Anst. xxx, p. 86 (1912).

† The Entomologist, xxxiv, p. 227 (1901).

‡ Schultze, Zool. und anthropol. Erg., Kgl. Preuss. Akad. der Wiss. Berlin, p. 17 (1912).

mirabilis, the type of the genus, possesses the large secretionary shield or flap over the large ventral orifice or not. If this remarkable structure is present in *Lophococcus mirabilis*, *Aspidoproctus* must go, but this matter cannot be settled without reference to the type.

Dactylopius (Pseudococcus) longispinus, Targ.

SOUTHERN NIGERIA : Lagos, on an unknown plant, 12. iv. 13 (*Dr. J. W. Scott Macfie*).

Dactylopius (Pseudococcus) virgatus, Ckll.

BRITISH GUIANA : Georgetown, 1912 (*G. E. Bodkin.*)

Ceronema africana, Macfie.

SOUTHERN NIGERIA : Ibadan, 14. vi. 13 (*Dr. W. A. Lamborn*).

Food-plant not determined. The following information was attached to the specimens : "These Coccids already dead on the branch of a bush shrub which had died apparently as a result of their influence."

Pulvinaria jacksoni, Newstead (fig. 4).

NYASALAND : on cotton, 14. vi. 13 (*E. Ballard*).

Mr. Ballard writes : "I had a whole cotton-plant brought to me the other day covered with the females and their ovisacs, and forward you a small branch."

Fig. 4.—*Pulvinaria jacksoni*, Newst., ♀♀ and puparia of ♂♂, on cotton branch ; nat. size.

The infestation was very heavy ; the thicker branches being almost completely covered by the long white ovisacs, while the male puparia were attached to the smaller twigs and quite isolated from the females.

Gold Coast: Aburi, 9. vii. 13 (*W. H. Patterson*).

Food-plant not stated. All the ovisacs in the consignment had been destroyed by a predaceous insect of some kind, so that nothing but the outline or tracks of the ovisacs were left.

Southern Nigeria: Ibadan, on cotton, 14. xii. 11 (*A. D. Peacock*).

Several mandibulate larvae belonging apparently to the Lepidoptera were found in association with the females and may have served therefore to keep this Coccid in check.

Lecanium (Saissetia) oleae, Bern.

Uganda: Entebbe, on *Hura crepitans*, 30. iii. 13 (*C. C. Gowdey*).

The alteration in the form of the females ("scales") and their antennae, due to Chalcidid parasites, is very marked in these examples; and although I have been unable to preserve the marginal spines in any of the microscopical preparations, the specimens are I consider referable to this species.

Lecanium (Saissetia) hemisphaericum (Targ.).

British Guiana: Georgetown, on leaves of *Solanum melongena*, 30. iii. 13 (*G. E. Bodkin*).

Lecanium (Saissetia) nigrum (Nietn.).

British Guiana: Brickdam Field, Georgetown, on hybrid cotton, 23. vii. 12 (*G. E. Bodkin*).

Lecanium (Eucalymnatus) tesselatum var. **perforatum,** Newst.

British Guiana: Broad St., Georgetown, on French cashew (*Eugenia jambolana*) 24. vii. 12 (*G. E. Bodkin*).

Vinsonia stellifera, Westwood.

British Guiana: Broad St., Georgetown, on French cashew (*Eugenia jambolana*), 24. vii. 12 (*G. E. Bodkin*).

Ceroplastes ugandae, Newstead.

Uganda: Entebbe, on pigeon pea (*Cajanus indicus*), 30. iii. 13 (young ♀♀), 30. v. 13 (old adult ♀♀) (*C. C. Gowdey*).

The tests of the old adult females being in a much more perfect state of preservation than those upon which the original description* was based, prove that *white secretionary matter from the stigmatic clefts is present on the exterior of the test and extends considerably beyond the latter in short, stout, irregularly curved processes.* The tests of the young females were so much damaged as to render them unsuitable for descriptive purposes.

Ceroplastes floridensis, Comstock.

British Guiana: Botanic Gardens, Georgetown, 1. iii. 13 (*G. E. Bodkin*).

* Bull. Ent. Res. ii, p. 94.

Conchaspis angraeci, Ckll.

DUTCH WEST INDIES: Curaçao, on an unknown plant, 17. i. 13 (*G. E. Bodkin.*)

Aspidiotus destructor, Signoret.

BRITISH GUIANA: Georgetown, on *Stephanotis* sp., 15. x. 13 (*G. E. Bodkin*).

Aspidiotus transparens, Green.

UGANDA: Kampala, on tea, 10. vii. 11 (*C. C. Gowdey*)

The leaves on the food-plant were practically covered with the insects and they must therefore have caused serious injury to the plants.

Aspidiotus hederae (Vall.)

NYASALAND: Blantyre, on *Grevillea robusta*, 2. iv. 13. (*E. Ballard*).

The puparia were all fixed to the undersides of the leaves; on the upper surface of the latter were a few male puparia of a species of *Lecanium.*

The *Aspidiotus* was heavily infested by Chalcidid parasites.

Aspidiotus cyanophylli, Signoret.

UGANDA: Entebbe, on peach, 4. xii. 12 (*C. C. Gowdey*).

The infestation was apparently not a heavy one.

Aspidiotus dictyospermi, Morgan.

SOUTHERN NIGERIA: Lagos, on avocado pear, 5. v. 13 (*Dr. J. W. Scott Macfie*).

Nearly all the Coccids had been attacked and destroyed by a very remarkable lichen-like fungus, so much so that only two perfect females could be found.

Aspidiotus cydoniae, Comstock.

BRITISH GUIANA: Georgetown, on egg-plant (*Solanum melongena*), 24. vii. 12 (*G. E. Bodkin*).

Aspidiotus (Chrysomphalus) biformis, Ckll.

BRITISH GUIANA: Georgetown, 24. iii. 13 (*G. E. Bodkin*).

On leaves of an undetermined orchid.

Aspidiotus (Chrysomphalus) bowreyi, Ckll.

BARBADOS: Dodd's Botanical Station, on *Agave*, 20. i. 13 (*J. R. Bovell*).

Aspidiotus (Pseudaonidia) baikeae, sp. n.

Female puparium.—Pure white or partly yellowish-white, form low convex or rather flat and usually deltoid, owing to the arrest of growth by the mid-rib or other prominent veins of the leaf. Larval pellicle green, margins yellowish. Ventral pellicle very thin, adhering to the plant. *Length* 2·50–3 mm.

Female adult (fig. 5*a*).—Somewhat ovate but produced distally. Integument thin and clear. Pro- and meso-thoracic segments strongly defined and deeply

articulated. Free abdominal segments well defined. Cephalo-thoracic area with many large and widely separated hairs. There are 9–18 parastigmatic glands just in advance of the anterior stigmata; their presence at the lower pair of stigmata is doubtful. Pygidium (fig. 5*b*) with *three* pairs of tricuspid lobes: central pair much the largest and also much more distinctly tricuspid; second and third pairs narrow, but well developed. Squamae strongly bifurcated distally. Spines long and rather stout. Dorsal surface of pygidium with a large and somewhat pyriform reticulated area, the reticulations small and irregular. Circumgenital glands absent. Tubular spinnerets *short*, pores large and arranged more or less in definite linear series.

Parasitised females (fig. 5*c*) much larger than the normal individuals and the integument highly chitinised and distended.

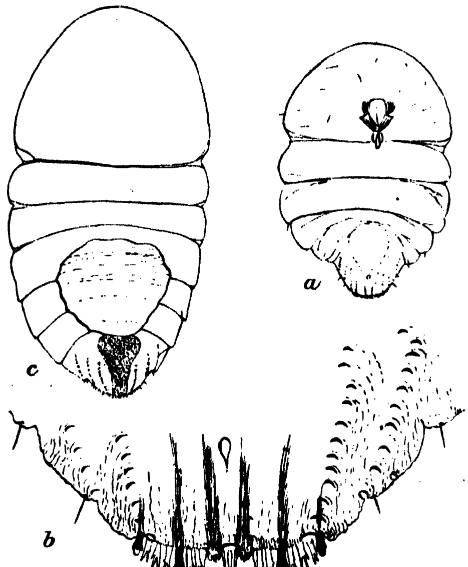


Fig. 5.—*Aspidiotus* (*Pseudaonidia*) *baikeae*, Newst.; *a*, adult ♀; *b*, fringe of pygidium of ♀; *c*, parasitised ♀.

Male puparium similar to that of the female but very much smaller. *Length* 1·50 mm.

UGANDA: Entebbe, on *Baikea insignis* and an unknown shrub, 6. iv. 13 and i. v. 13 (*C. C. Gowdey*).

Diaspis boisduvalii, Sign., occurred in association with this Coccid, but the puparia of the latter were not fixed near the mid-rib of the leaves.

This insect is closely allied to *Aspidiotus* (*Pseudaonidia*) *trilobitiformis*, Green, but is distinguished by the colour of the puparia; and in the female by the absence of circumgenital glands, and also by the character of the fourth pair of lobes to the pygidium.

Aspidiotus (Pseudaonidia) fossor, sp. n.

Female puparium sub-circular, highly convex, black or piceous, very thick and strong, but invariably covered with a superficial layer of bark, so that it is

highly protected and inconspicuous. Larval pellicle (not buried beneath the bark) placed centrally, colour red, or dull orange red; second pellicle dull castaneous. Under surface black, smooth, but with a thin pearly grey secretion. Ventral pellicle thick, greyish, with a well defined black margin and a subcentral circular white patch, between which and the margin the sublying blackish secretion shows through in fine dark and somewhat concentric lines. *Greatest diameter*, 2·50 mm.

Female adult.—Very broadly ovate or rotund. Thorax deeply constricted and with a few scattered hairs; integument strongly chitinised. Rudimentary antennae with a single long straight hair not much larger than the scattered hairs on the surrounding integument. Parastigmatic glands present near all the stigmata: anterior pair usually with four, posterior pair with one or two. Second and third abdominal segments with a large group of minute tubercular spinnerets near the margin; the remaining segments as also the proximal portion

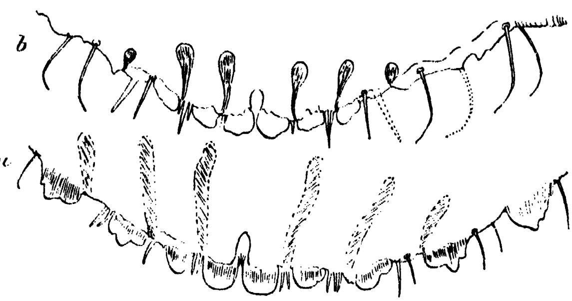


Fig. 6.—Pygidium of adult ♀ of: *a*, *Aspidiotus* (*Pseudaonidia*) *fossor*, Newst.; *b*, *A. tesseratus*, de Charmoy.

of the pygidium with a continuous band of similar spinnerets. Pygidium reticulated; without circumgenital glands; anal orifice placed a little in advance of the median pair of "thickenings of the body-wall"; the latter in two pairs are almost straight and of uniform thickness throughout; margin (fig. 6*a*) with three pairs of lobes and two pairs of dentate projections, the latter generally larger and therefore more conspicuous than the lobes; spines and squamae very short, the latter, as a rule, do not project beyond the lobes, or if so, only very slightly. *Length* 1·50 mm.

BARBADOS: Queen's Park, on grape vine, 21. i. 13 (*J. R. Bovell*).

This Coccid possesses the power of burrowing beneath the bark of its food-plant to the same marked extent as *Chionaspis* (*Howardia*) *biclavis*, Comst. In its structural characters it very closely resembles *Aspidiotus* (*Pseudaonidia*) *tesseratus*, de Charmoy, but has relatively much shorter spines and squamae; the thickenings of the body-wall are longer and of uniform width throughout; and the dentate projections of the margin of the pygidium are also much more markedly pronounced.

Aspidiotus (Pseudaonidia) tesseratus, de Charmoy. (Fig. 6*b*).

BARBADOS: Dodd's Botanical Station, on *Cassia fistula*, 1913 (*J. R. Bovell*).

Aspidiotus (Pseudaonidia) trilobitiformis, Green.

ZANZIBAR: On baobab (*Adansonia digitata*), 20. v. 13 (*Dr. W M. Aders*).

The puparia, all females, were arranged along the mid-rib of the leaf. Those on the upper surface being much paler than those on the underside of the leaf, owing apparently to the action of stronger light.

Aspidiotus (Selenaspidus) articulatus, Morgan.

BRITISH GUIANA: Georgetown, on Liberian coffee and an ornamental palm, 23. vii. 12 (*G. E. Bodkin*).

UGANDA: Banda, Chagwe, on coffee, 14. xii. 12 (*C. C. Gowdey*).

The examples from Uganda were unusually large, many of them being twice the size of those from the West Indies.

Diaspis boisduvalii, Signoret.

BRITISH GUIANA: East Coast, 2. iii. 13, and Botanic Gardens, Georgetown, on *Catleya superba* and plantain.

UGANDA: Entebe, on *Baikea insignis* and an unknown shrub, 6. iv. 13 and 1. v. 13 (*C. C. Gowdey*).

There are some very slight morphological differences between the African examples and those found under glass in Europe, but I cannot separate them specifically.

Chionaspis citri, Comstock.

BRITISH GUIANA: Georgetown, on lime and orange, 27. vii. 12 (*G. E. Bodkin*).

Chionaspis funtumiae, sp. n.

Female puparium.—Opaque white or pale ochraceous; form usually broadly dilated immediately behind the second pellicle. Larval pellicle dull yellow, with a dusky median area; second pellicle partly covered with a thin translucent secretion. Ventral pellicle exceedingly thin and adhering to the plant. *Length* 2·5–2·9 mm.

Male puparium opaque white or pale ochraceous; *non-carinated, the texture similar to that of the female*; sides slightly bulging, very narrowly pyriform or rarely parallel. Occasionally it is slightly contorted or curved. *Length* 1·5–1·6 mm.

Female adult.—Markedly narrowed in front. Rudimentary antennae with 2–3 curved spines, one of them slightly stouter than the rest. Anterior pair of spiracles with 5–6 parastigmatic glands; posterior pair usually with 2–3. Proximal half of the margin of the thoracic area with numerous small pores; and many slightly larger pores on the abdominal segment. Genital orifice very slightly in advance of the anal opening; both organs placed proximally. Pygidium (fig. 7) small. Median lobes large, widely separated, suddenly attenuated distally, lateral margins faintly serrated, striae distinct, parallel; second pair of lobes duplex and unequal; third pair somewhat rudimentary and sometimes also duplex. Squamae spiniform and arranged in pairs between the lobes and one pair beyond the latter. Spines minute. *Circumgenital glands absent.*

UGANDA: Entebbe, on *Funtumia latifolia*, 27. v. 13. (*C. C. Gowdey*). The infestation is extensive, the twigs being partly covered by the puparia.

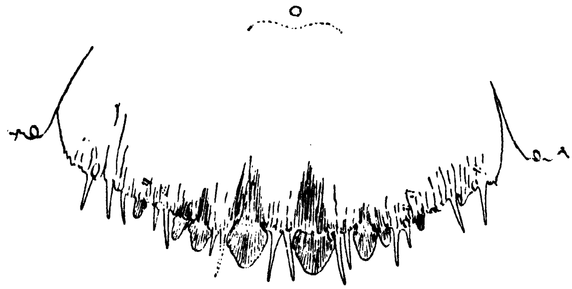


Fig. 7.—*Chionaspis funtumiae*, Newst.; fringe of pygidium of adult ♀.

The absence of longitudinal carinae in the puparia of the male of *Chionaspis* is very rare indeed; in this species there is not even a faint trace of them, and what is still more remarkable, they are similar in texture to those of the female. The widely separated and somewhat obconical lobes of the pygidium, in the female, with their bilateral serrations, are also markedly characteristic and bear a rather striking resemblance to the corresponding organs in *Mytilaspis* (*Lepidosaphes*) *chitinosus*, Lindinger (Jahrb. Hamb. Wiss. Anst, xxvi, p. 34, 1909).

Chionaspis (Howardia) biclavis var. **detecta** (Mask.).

BRITISH GUIANA: Botanic Gardens, Georgetown, on *Sapium jenmani* and jasmin (*Tabernaemontana walichii*), 23. vii. 12 and 31. i. 13 (*G. E. Bodkin*).

Mytilaspis (Lepidosaphes) beckii (Newman).

BRITISH GUIANA: Georgetown, on lime (Citrus) and crotons, 24 & 29. vii. 12 (*G. E. Bodkin*).

Pinnaspis buxi (Bouché).

BRITISH GUIANA: Botanic Gardens, Georgetown, on ornamental palms, 23. vii. 12 (*G. E. Bodkin*).

BARBADOS: Merton Lodge, on *Alocasia* sp., 22. i. 13 (*J. R. Bovell*).

Ischnaspis filiformis (Douglas).

BRITISH GUIANA: Botanic Gardens, Georgetown, on ornamental palm, 23. vii. 12 (*G. E. Bodkin*).

SOUTHERN NIGERIA: Lagos, 7. iv. 13 (*Dr. J. W. Scott Macfie*).

Found "on an unknown tree near pond" in association with a species of *Aleurodes*.

Parlatoria ziziphus (Lucas).

BRITISH GUIANA: Georgetown, on lime tree (Citrus), 24. vii. 12 (*G. E. Bodkin*).

December 4th, 1913.

AFRICAN APHIDIDAE.

By Fred. V. Theobald, M.A., F.E.S., Hon. F.R.H.S.

Our knowledge of the Aphididae of Africa is as yet very limited, this important group of insects having been but little studied, except in Europe and North America. At present only thirty-five species are recorded for the whole African continent, about the number one can collect in a single afternoon in one's own garden in England. It will be noticed that several common European species are recorded, and that they are as destructive in Africa as in Europe, such as the Common Cabbage Aphis (*A. brassicae*) and the Ribes and Lettuce Aphis (*Rhopalosiphum lactucae*). Several others occur which have a world-wide distribution, such as the Black Peach Aphis (*Aphis persicae*), and the Woolly Aphis (*Eriosoma lanigerum*), doubtless having been distributed on nursery stock, the former as ova and the latter as adults. Fuller has reported destroying and fumigating strawberry plants attacked by Aphis sent from Europe, and Lounsbury records the presence of Apple Aphis eggs on imported stock. Undoubtedly these insects are constantly being distributed from country to country with imported plants, trees and shrubs.

Nine new species are described here for the first time. As I have seen only formalin or spirit specimens the actual colours of the new species cannot be given. It would be well for collectors to make a note on the general coloration of the species they send.

List of African Aphididae.

Macrosiphum lophospermum, sp. nov.
„ *lycopersicella*, sp. nov.
„ *antirrhinum*, Macchiate.
„ *granarium*, Kirby.
„ *rosae*, Linnaeus.
„ *neavei*, sp. nov.
Macrosiphoniella bedfordi, sp. nov.
Rhopalosiphum lactucae, Kaltenbach.
„ *dianthi*, Schrank.
Aphis brassicae, Linnaeus.
„ *sorghi*, Theobald.
„ *sorghella*, Schouteden.
„ *gossypii*, Glover.
„ *pomi*, Réaumur.
„ *tavaresi*, Del Guercio.
„ *solanella*, sp. nov.
„ *persicae*, Boyer.
„ *ligustriella*, sp. nov.
„ *nigripes*, sp. nov.
„ *coffeae*, Nietner.
„ *nerii*, Boyer.

Aphis rumicis, Linnaeus.
„ *africana*, sp. nov.
Hyalopterus pruni, Fabricius.
Toxoptera theobromae, Schouteden.
„ *aurantiae*, Boyer.
„ *graminum*, Rondani.
Tuberculatus quercus, Kaltenbach.
Dryaphis persicae, Cholodkovsky.
Lachniella thujafolia, sp. nov.
Eriosoma lanigerum, Hausmann.
Rectinasus buxtoni, Theobald.
Forda rotunda, Theobald.
Phylloxera corticalis, Kaltenbach.
„ *vastatrix*, Planchon.

Myzus persicae, Sulzer, and *M. cerasi*, Fabricius, have been recorded, but in error for *Aphis persicae*, Boyer.

Macrosiphum lophospermum, sp. nov.

Alate male.—Green; head dark; disc of thorax black; antennae longer than the body, dark brown, base of third segment pale, the third scarcely longer than the fourth, the fourth longer than the fifth, the sixth about as long as four and

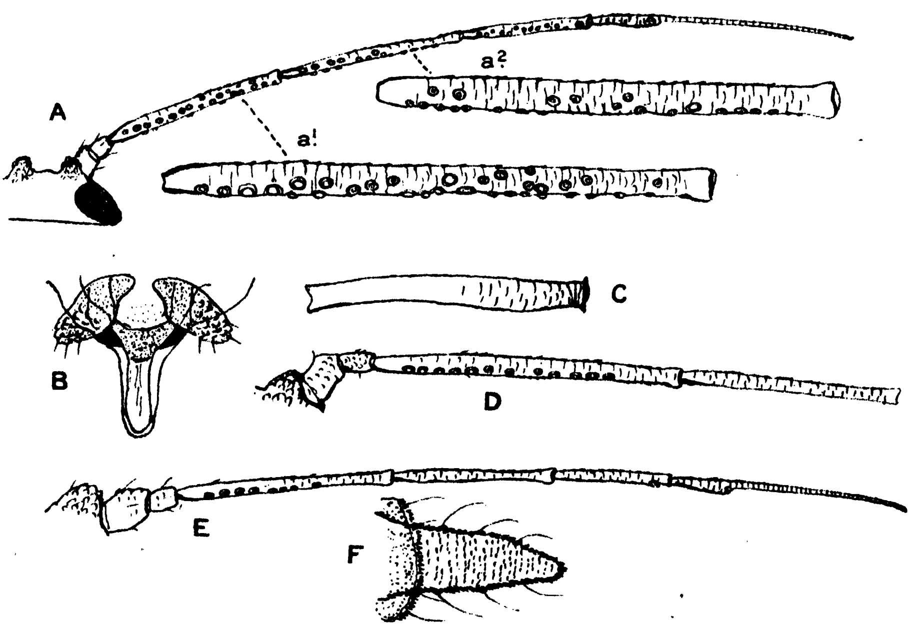


Fig. 1.—*Macrosiphum lophospermum*, Theo.; (A) head and antenna of ♂; a^1, 3rd segment of antenna; a^2, 4th segment; (B) male genitalia; (C) cornicle; (D) antenna of alate ♀; (E) antenna of apterous ♀; (F) cauda of apterous ♀.

five; the third segment with 22–24 sensoria extending along the whole length, the fourth with 20–22 sensoria along the whole length, the fifth 15–17 sensoria

extending up to the large subapical one; the antennae arise from moderately large frontal lobes. Eyes large, black. Proboscis thin, reaching to the second pair of legs. Abdomen green, with three pairs of brown lateral spots before the cornicles and traces of small dark transverse bars. Cornicles dark brown, slightly swollen along the apical half, rather long, reaching just beyond the cauda, imbricated, with one or more lines across the apex. Penis nude, ochreous, claspers dark, imbricated, spinose. Fore femora mostly pale, darkened at the apex, mid and hind femora mostly dark; tibiae pale, dark at the apex, hind tibiae very long; tarsi dark; tibiae with many short, fine, pale hairs. Wings with pale brown veins and stigma. *Length*, 1·5 mm.

Alate viviparous female.—The third segment of the antennae has a line of 12 sensoria on one side, the third segment being longer than the fourth, the first is large and angulated and the frontal tubercles are more prominent than in the male. The cornicles similar in form to those of the male, imbricated, with two transverse striae, the lower one being furcate on one side; cauda with apparently only two pairs of lateral bristles; wings normal, with yellowish brown veins and stigma. *Length*, 1·8 mm.

Apterous viviparous female.—Green, with small dark lateral spots; head darker; legs pale, apex of tibiae and tarsi dark; proboscis dark at the apex. Eyes black. Antennae longer than the body, the sixth segment and the apex of the fifth dusky; the third segment longer than the fourth with seven to nine sensoria, the fourth longer than the fifth. Cornicles long, thin, slightly expanded on the apical half, pale, dusky at the apex, projecting well beyond the cauda; faintly imbricated, the apex with one or two striae; cauda pale, ensiform, with three pairs of lateral chaetae. *Length*, 1·3–2 mm.

BRITISH EAST AFRICA: Njoro, i. 1912 (*T. J. Anderson*).

FOOD-PLANT: *Lophospermum erubescens.*

Described from a single alate male, many apterous viviparous females and a single damaged skin (parasitised) of the alate viviparous female. The colours are taken from spirit specimens, but were still marked.

Macrosiphum lycopersicella, sp. nov.

Apterous viviparous female.—Entirely greenish, with large black eyes, dusky tarsi and dusky apices to the tibiae. Antennae as long as or longer than the body, arising from prominent frontal tubercles, which are imbricated; first segment large, the second shorter and much narrower, the third the longest, the fourth a little shorter than the third, fifth a little shorter than the fourth, the sixth about as long as four and five together, a sensorium near the apex of the fifth, and a group at the constriction of the sixth, all the segments imbricated; apex of the fifth and all the sixth brown, a few spine-like short hairs; two hairs on the frons, and a few on the lateral lobes. Eyes large and black. Cornicles long, projecting much further than the cauda, narrow, slightly swollen on the apical half, green, dusky at the apex, faintly imbricated, the apex with one or two striae. Cauda large, pale green, bluntly pointed, with lines of fine points, and three pairs of lateral hairs. Legs long and thin, especially the tibiae; apex of tibiae and the tarsi dusky brown, hairy, ungues dark. Rostrum reaching just

past the second coxae, dusky at the apex, last segment narrow, the penultimate rather broad. *Length*, 1·5–2 mm.

BRITISH EAST AFRICA: Njoro, 16. i. 12 (*T. J. Anderson*).

FOOD-PLANTS: Cape Tomato and Rape.

Described from several mature apterous viviparous females and some immature forms, also one nymph, in which the wing-cases are very large and darker than the rest of the body, the cornicles and antennae relatively shorter and the pale green tail triangular, as seen in the immature females. The apical swelling of the cornicles varies to some extent.

Specimens sent from Rape agree exactly with those sent from the Cape Tomato.

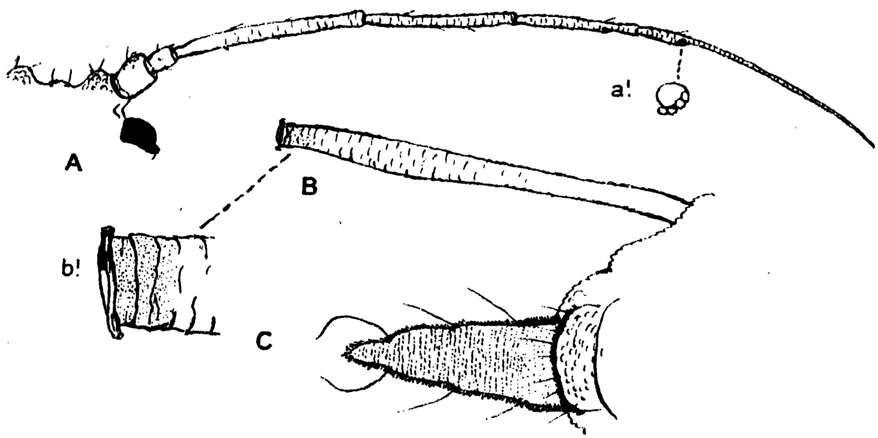


Fig. 2.—*Macrosiphum lycopersicella*, Theo., apterous ♀; (A) head and antenna; a^1, sensoria of 6th segment; (B) cornicle; b^1, apex of cornicle; (C) cauda.

In America, Clarke has described an aphis from tomatoes as *Nectarophora lycopersici* (Canad. Ent. xxxv, p. 253, 1903), but the antennae of the species described here do not agree with those of the American species.

Macrosiphum neavei, sp. nov.

Apterous viviparous female.—Reddish brown; antennae about as long as the body, pale reddish brown, two basal segments dark; legs with the apices of the fore femora, and most of the mid and hind, dark brown, fore and mid tibiae dark at the base and apex, hind with apical half and the base dark; tarsi dark; femora with a few stiff hairs; tibiae with many hairs. Cornicles, cauda and anal plate black. Body with stiff moderately long hairs arising from distinct tubercles, slightly darkened. Eyes black. Basal segment of the antennae much broader and slightly longer than the second, both dark and with a few stiff hairs; third segment longer than the fourth, rather swollen towards the base, with several hairs on the inner border, three or four on the outer; fourth and fifth segments nearly equal, the two together a little longer than the third, both with a few stiff hairs, the fifth with a sub-apical sensorium; sixth nearly as long as the third, fourth and fifth, basal area short; fourth to

sixth imbricated. Cornicles cylindrical, slightly swollen at the base, black, thick, longer and thicker than the third antennal segment and much longer than the cauda, marked with fine dark specks, scarcely to be called imbrication; cauda black, spinose, bluntly acuminate, dilated basally, with three pairs of pale lateral chaetae (one shows a fourth on one side). *Length*, 2 to 2·5 mm.

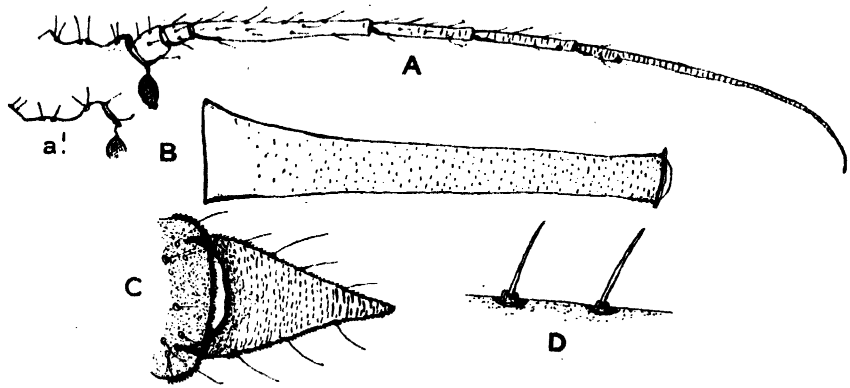


Fig. 3.—*Macrosiphum neavei*, Theo., apterous ♀; (A) head and antenna; (B) cornicle; (C) cauda; (D) body hairs.

Nymph.—Very similar to the apterous female, the wing-buds dark brown. *Length*, 2 to 2·5 mm.

NYASALAND: Mlanji, iv. 1913 (*S. A. Neave*).

Described from two apterous females and some nymphae. No food-plant is recorded. The ornamentation of the cornicles is very marked.

Macrosiphum antirrhinum, Macchiate.

Siphonophora anterrhinum, Macchiate.

Macchiate, Ann. Soc. Ent. Ital. xv, p. 228 (1883); Theobald, Journ. Eco. Biol. viii, p. 151–153, fig. 59 (1913).

BRITISH EAST AFRICA: Njoro, 16. i. 12 (*T. J. Anderson*).

FOOD-PLANTS: *Antirrhinum* spp. (cultivated).

The only other records are Italy (*Macchiate*) and Glasgow, Scotland (*Agar*).

Mr. Anderson obtained the alate ♀ and many apterae. No alate females have occurred in Britain, yet Mr. Agar, of Glasgow University, has bred this Aphis all the year.

Macrosiphum granarium, Kirby (The European Grain Louse).

Aphis granaria, Kirby.
Aphis cerealis, Kaltenbach.
Siphonophora cerealis, Koch.

Kirby, Trans. Linn. Soc. iv, p. 238 (1798); Curtis, Journ. Roy. Soc. Agric. vi.; Kaltenbach, Mon. Pflanz. p. 16 (1843); Koch, Pflanzenläuse, p. 186 (1857); Buckton, Mon. Brit. Aph. i, p. 114, pl. vi (1875); Pergande, Bull. 44. U.S. Dept. Agric. Div. Ent. pp. 13–21 (1904); Theobald, Journ. Eco. Biol. viii, pp. 58–61, figs. 283 (1913).

BRITISH EAST AFRICA : Njoro, i. 12 (*T. J. Anderson*).—Also found all over Europe and North America, and in India (Buckton).*

FOOD-PLANTS : Broom Corn (Africa) ; also wheat, oats, barley, *Avena fatuae*, *Bromus mollis*, *Dactylis glomerata*, *Secale cereale*, *Triticum sativum*, *Hordeum murinum*, *Holcus* spp., *Poa* spp., *Glyceria fluitans*, *Polygonum persicariae*, etc.

The African specimens agree exactly with those from Europe.

Macrosiphum rosae, Linnaeus (Rose Green Fly).

Aphis rosae, Linnaeus.
Siphonophora rosae, Koch.
Aphis dipsaci, Schrank.

Réaumur, Mem. iii, p. xxi, figs. 1–4 (1737) ; Linnaeus, Syst. Nat. i, 2, p. 734 (1767) ; de Geer, Ins. iii, p. 65, pl. iii, fig. 10 (1773) ; Schrank, Fn. Boica, ii, 1, pp. 104 and 117 (1801) ; Fabricius, Syst. Rhyng. p. 298 (1803) ; Kaltenbach, Mon. Pflanz. p. 3 (1843) ; Koch, Die Pflanz. p. 178 (1857) ; Buckton, Mon. Brit. Aph. i, p. 103 (1875) ; Fuller, First Rept. Gov. Ent. 1899–1900, p. 95 (1901) ; Theobald, J. Econ. Biol. viii, p. 55 (1913).

NATAL ; TRANSVAAL : Pretoria (*Bedford*).—Also Europe generally, America and India.

FOOD-PLANTS : Roses, both wild and cultivated.

Siphonophora citrifolii, Ashmead.

An aphis has been recorded under this name as occurring on oranges in Africa ; as pointed out later, it is only *Aphis gossypii*, Glov. Gowdey probably refers to this species when he speaks of *Aphis citri*, Ashmead (Uganda Insect Pests, Ent. Leaflet No. 2, p. 7, 1909). Hubbard (Insects affecting the Orange, U. S. A. Dept. Agric. Div. Ent. p. 157, pl. xiii, fig. 3) refers to the Orange Aphis as *S. citrifolii*, Ashmead, but his figures are of a *Toxoptera*. Saunders (Insects Injurious to Fruits, p. 388, fig. 398, 1892) also under this name figures a *Toxoptera*.

Macrosiphoniella† bedfordi, sp. nov.

Apterous viviparous female.—Blackish ; antennae longer than the body, the basal part of the third segment pale ; legs pale, the apical two-thirds of the femora, base and apex of the tibiae and the tarsi, black. Cornicles and cauda black. Antennae with the first segment considerably larger than the second, both black ; the third the longest, not quite as long as the fourth and fifth together, with 18 to 20 sensoria along the outer border for nearly the whole length ; fourth segment shorter than the third, about as long as the fifth ; the sixth about as long as four and five together ; a subapical sensorium on the fifth and a group at the junction of the basal area and flagellum in the sixth ; the first and second segments, with a few long hairs, the third with about ten outstanding ones on the outside, three on the fourth and two on the fifth. The head is concave in front, with several long hairs ; frontal processes not very marked ; eyes prominent ; the proboscis does not quite reach the third pair of legs. Abdomen with a few long outstanding pale hairs. Cornicles black, of

* Buckton's record may be an error, as a very similar aphis attacking roses has recently been sent to me from Lahore by Bashambar Das, which he is describing as *M. rosaeiformis*.

† This is a genus recently created by Del Guercio for a closely related chrysanthemum species.

moderate length, much expanded basally, the apical two-thirds with large reticulations, the basal area imbricated; about two-thirds the length of the cauda. The cauda is black, longer than the cornicles, narrow and bluntly acuminate, with five hairs on each side and six or seven on the dorsum near

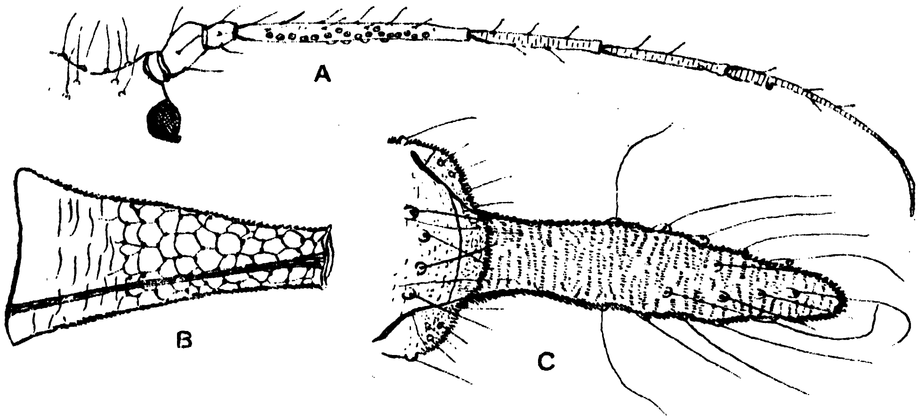


Fig. 4.—*Macrosiphoniella bedfordi*, Theo., apterous ♀; (A) head and antenna; (B) cornicle; (C) cauda.

the apex; anal plate dark, with six prominent long chaetae and two or more less distinct. Legs moderately long, tibiae much thinner than the femora; both femora and tibiae with rather long stiff hairs, denser on the tibiae than on the femora; the base of the femora and most of the mid area of tibiae paler. *Length*, 1·5 to 1·8 mm.

TRANSVAAL: Onderstepoort, 6. iv. 13 (*Gerald Bedford*).

FOOD-PLANTS: Cultivated chrysanthemums.

This species at first sight resembles Del Guercio's *Macrosiphoniella chrysanthemi*,* but cannot be conspecific, for the first two antennal segments are markedly unequal and not equal as in that species, and the cornicles are much thicker and more expanded basally. No mention is made of their ornamentation by Del Guercio, nor as to the presence of antennal sensoria in the apterous female, and the antennae in the Transvaal species are longer than the body.

Rhopalosiphum lactucae, Kaltenbach (The Currant and Lettuce Aphis).

Aphis lactucae, Kaltenbach.

Rhopalosiphum ribis, Buckton (*nec* Linnaeus).

Rhopalosiphum lactucae, Buckton, Passerini.

Kaltenbach, Mon. Pflanz., p. 37 (1843); Buckton, Mon. Brit. Aph. ii, pp. 9–10 (1877); Theobald, J. Econ. Biol. vii, pp. 105–107, pl. iii, fig. 2 (1912).

BRITISH EAST AFRICA: Njoro, i. 1912 (*T. J. Anderson*).—Europe generally.

FOOD-PLANTS: *Ribes* spp.; *Sonchus*, *Lactuca*, *Lapsana vulgaris*, *Picris hieracioides*, and *Cichorium endivum*.

The African specimens were found on sow-thistles (*Sonchus*) and agree exactly with British examples.

* Redia, vii, p. 332, fig. 30 (1911).

Rhopalosiphum dianthi, Schrank (The Green Peach Aphis).

Aphis dianthi, Schrank.
Aphis vulgaris, Kyber.
Aphis dubia, Curtis.
Myzus persicae, Passerini.
Aphis vastator, Smee.

Schrank, Fn. Boica, ii, 1, p. 114 (1801); Kyber, Germ. Mag. i, 2, p. 9. (1815); Curtis, J. Roy. Agric. Soc. iii, p. 54, pl. c., fig. 4 (1842); Kaltenbach, Mon. Pflanz. p. 42 (1843); Walker, Zoologist, vi, pp. 2218, 2246 (1848), vii, pp. xlvi, lv–lvii (1849), viii, pp. ciii, civ (1850); Walker, Ann. Nat. Hist. (2) v, p. 391 (1852); Passerini, Aphid. Ital., p. 20 (1863); Smee, Potato Plant, p. 81; Buckton, Mon. Brit. Aph. ii, p. 15, pl. xliii figs. 1–4, (1877).

TRANSVAAL: Pretoria, 1. viii. 1913 (*G. Bedford*); CAPE COLONY: along Orange River (*Lounsbury*).—Europe, India and North America.

FOOD-PLANTS: *Amygdalus amygdalus*, *Oxalis rosea*, *Onopordon acanthium*, *Potentilla recta*, *Chaerophyllum roseum*, *C. aromaticum*, *Syringa vulgaris*, *Sisymbrium austriacum*, *Cochlearia armoracea*, *Nasturtium officinale*, *Nerium oleander*, *Solanum tuberosum*, etc.; Rape in (India).

This aphis was sent to me with *Aphis persicae* from Pretoria, and I expect Lounsbury's reference (Leaflet 33, Dept. Agric. Cape Col. 1908) to a green Peach Aphis found in the district along the Orange River, refers to this species. It is abundant on peaches in Europe, and the apterae are pink as well as green. It curls the leaves like, but not to the same extent as, the dark species.

Aphis brassicae, Linnaeus (The Cabbage Aphis).

Aphis floris rapae, Curtis.
Aphis raphani, Schrank.
Aphis isatidis, Boyer.

Linnaeus, Syst. Nat. i, 2, p. 734 (1767) and Fn. Suec. p. 985 (1789); Curtis, Farm Insects, p. 68 (1883); Schrank, Fn. Boica, ii, 1, p. 119 (1801); Boyer, Ann. Soc. Ent. France, x. p. 165 (1841); Lounsbury, Cape Agric. Journ. (14th Sept. 1899); Fuller, First Rep. Govt. Ent. Natal, p. 95 (1901); Dewar, First Rep. Govt. Ent. Orange River Col. p. 24.

CAPE (*Lounsbury*); TRANSVAAL (*G. Bedford*); NATAL (*Fuller*); ORANGE RIVER COLONY (*Dewar*); NYASALAND: Zomba, 17. vi. 13 (*Ballard*); BRITISH EAST AFRICA: Nairobi (*Dr. Andrews*).—Europe and America generally, Australia, Japan and India.

FOOD-PLANTS: All Cruciferae.

Fuller refers to this insect as doing a great deal of injury to turnip crops in Natal. Lounsbury says that this cabbage aphis is familiar to the farmers from one end of Cape Colony to the other, and that it is probably an imported pest. Specimens sent to me some years ago by Dr. Andrews, late Director of Agriculture of the East Africa Protectorate, were undoubtedly this species. French records it from Australia (Handbk. Dest. Ins. Victoria, ii, p. 165, pl. xxxv).

Aphis sorghi, Theobald (The Asal Fly).

Theobald, First Rept. Wellcome Res. Labs. pp. 43–45, pl. c. (1904); *id.*, Second Rept. pp. 39 & 96 (1906); *id.*, Third Rept. p. 95 (1911); Morstatt, Der Pflanzer, Daressalam, ix, p. 295 (1913).

SUDAN: Kassala, Senaar, Bahr-el-Ghazal, Rahad, Khartoum, Berber (*Balfour & King*); SOUTHERN NIGERIA (*Jemmett*); GERMAN EAST AFRICA (*Morstatt*); CAPE COLONY: Transkei (*Lounsbury*).

FOOD-PLANTS: Sorghum and Guinea Corn.

This is the Dura pest of the Sudan; it is also destructive in the Native Territories of the Cape, often appearing in vast swarms.

Coccinella undecimpunctata, *Chilomenes vicina* and *Exochomus nigromaculatus* have been recorded as preying on this species.

Aphis sorghella, Schouteden.

Schouteden, Ann. Soc. Ent. Belg. l, p. 137 (1906).

TOGO: on Sorghum (*Busse*).

Aphis gossypii, Glover (The Cotton and Melon Aphis).

Aphis (*Siphonophora*) *citrifolii*, Ashmead.
Aphis citrulli, Ashmead.
Aphis cucumeris, Forbes.

Glover, Patent Office Report, p. 62 (1854) and *ibid.* p. 68 (1855); Glover, Rept. Dept. Agri. U.S.A. p. 36 (1876); Ashmead, Orange Insects (1880), and Florida Dispatch, n. 5, vol. i, p. 241 (1882); Forbes, Twelfth Rept. Nox. and Benef. Ins. Illinois, pp. 83–91 (1883); Pergande, Insect Life, vii, pp. 309–315 (1895); Theobald, Sec. Rept. Well. Lab., p. 93 (1906); Lounsbury, Agric. Journ. Cape Col. (Oct. 1908); Vassiliev, Trd. b. entom. učen. Kom. Gl. Upr. Zeml. St. Petersburg, viii, 6, pp. 1–24. figs. 1–8 (1910).

CAPE COLONY: Cape Peninsula, Paarl, Uitenhage (*Lounsbury*); TRANSVAAL: Onderstepoort, on *Cosmia*, 6. iv. 1913 (*G. Bedford*); Christiania, on melons and cucumbers, 16. iv. 1913 (*G. Bedford*); BRITISH EAST AFRICA: Njoro, on cotton, 16. i. 1912 (*T. J. Anderson*); UGANDA: Entebbe (*C. C. Gowdey*); SUDAN: Kamlin (*Dickinson*); EGYPT: Cairo, on cotton and Hibiscus (*F. C. Willcocks*); SOUTHERN NIGERIA: Ibadan, on cotton, viii. 1912 (*A. D. Peacock*); KAMERUN: on cotton (*Busse*).—North America generally; Bonito, Mexico (*Townsend*); Montserrat, British West Indes (*Hubbard*); Brazil (*Koebele*); Adelaide, Australia (*Koebele*); India (*Lefroy*); England (*Theobald*); Russia (*Vassiliev*).

FOOD-PLANTS: Cottons (*Gossypium*), *Lycospermum*, Winter Nightshade (*Solanum* sp.), Melons, Cucumbers, and rarely on Oranges, in Africa. In England on Melons, and in America practically on all Cucurbitaceae, *Portulaca oleracea*, *Capsella bursa-pastoris*, *Lepidium virginicum*, *Rumex* spp., *Lappa major*, *Taraxacum dens-leonis*, *Chenopodium album*, *Plantago virginica*, *Stellaria media*, *Convolvulus* sp., *Acalypha virginica*, *Diodiateres*, *Nepeta glechoma*, *Trifolium pratense*, *Malva rotundifolia*, *Phaseolus nanus*, *Spinacia oleracea*, *Humulus lupulus*,

Pyrus communis, *Cornus mas* and all varieties of *Citrus*; *Datura stramonium*, *Cosmia* sp., *Begonia*, *Hydrangea*, *Hibiscus*, etc.

The African specimens sent me by Mr. F. C. Willcocks from Lower Eygpt and those from British East Africa and the Transvaal agree exactly with the American specimens I have and with those found on melons under glass in Britain.

The species is subject to great variation in colour, ranging from pale greenish yellow to almost black, but can at once be told by the antennal sensoria of the alate female and by the cauda.

Pergande says the sensoria on the third antennal segment in the alate female vary from 5 to 7. I have several times counted as many as 8, never more, the usual number being 5. It is probably a world-wide species. It is thought by Lounsbury to be indigenous to Africa, where it was first noticed in 1907 attacking melons. Whole fields of watermelons and cucumbers were killed in the Cape Peninsula, and calabashes were also attacked. The aphis that caused such

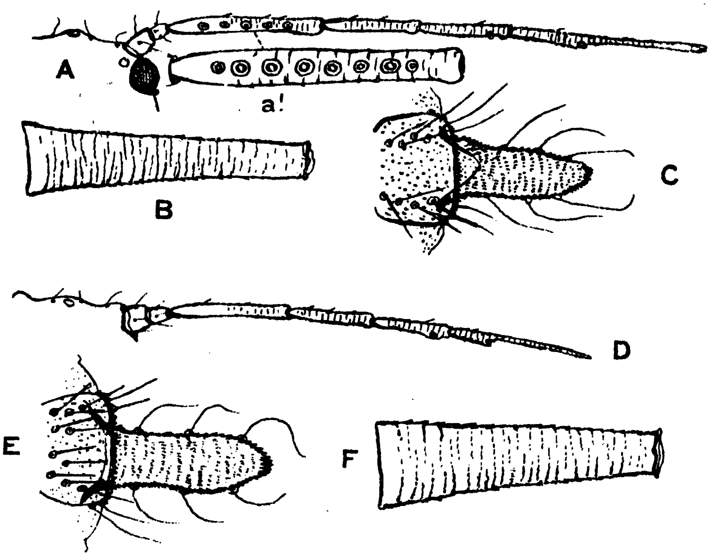


Fig. 5.—*Aphis gossypii*, Glov.; (A) head and antenna of alate ♀; (B) cornicle, and (C) cauda of alate ♀; (D) head and antenna, (E) cauda, and (F) cornicle of apterous ♀.

loss to melon-growers in 1896 at Constantia, the Cape Flats and Paarl was undoubtedly this species. Lounsbury speaks and writes of it as the Melon Aphis.* In America it appears to be common on oranges, but in Africa it is rare upon Citrus fruits. The aphis from melons in the Sudan that I thought was probably Koch's *A. malvae* is *A. gossypii*, and it also occurs commonly on *Cosmia* sp. in the Transvaal.

Gillette (Journ. Econ. Ent. i, pp. 176–181) states that so far no eggs of this species have been found. Reproduction appears to be entirely asexual, as is the case with *Aphis abietina*, Walk., in Britain.

In Africa *A. gossypii* is preyed upon by a Ladybird Beetle (*Chilomenes lunata*) and by several species of Syrphid larvae. In India it is attacked by a *Trionyx* sp. (Lefroy).

* Leaflet 28, Dept. Agric. Cape Col. (1906).

Aphis pomi, de Geer (The Green Apple Aphis).
Aphis mali, Fabricius.
Aphis malifoliae, Fitch.
Aphis pyri, Kittel.

De Geer, Ins. iii, p. 53, pl. iii, figs. 18–26 (1773); Fabricius, Syst. Ent. p. 737 (1775); Schrank, Fn. Boica, ii, 1, p. 116 (1801); Latreille, Gen. Crust. iii, p. 173 (1802); Kaltenbach, Mon. Pflanz. i, p. 72 (1843); Walker, Zoolog. vi, p. 2281 (1848), and Ann. Nat. Hist. (2) v, p. 269 (1852); Fitch, The Senate, no. 30, p. 65; Buckton, Mon. Brit. Aph. ii, p. 44, pl. I (1877); Dewar, Farmers' Bulletin, Orange R. Col. viii, p. 12 (1905); Theobald, Insect Pests of Fruit, p. 133, figs. 105–108 (1909).

ORANGE FREE STATE (*Dewar*).—Europe, Japan and America.

FOOD-PLANTS: Apples.

The only African record is Dewar's, but Lounsbury refers to the ova being found on imported stock.

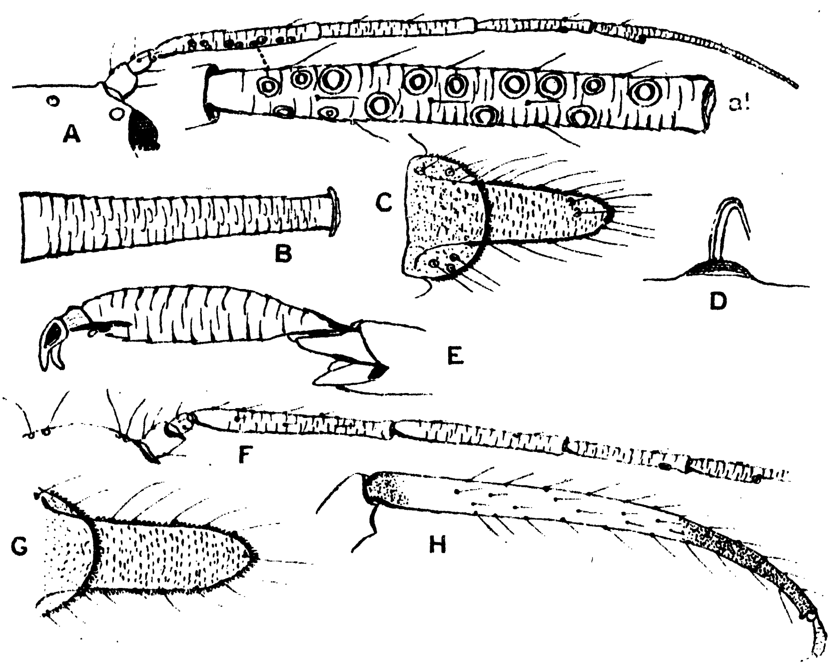


Fig. 6.—*Aphis tavaresi*, Del Guercio; alate ♀, (A) head and antenna, (B) cornicle, (C) cauda, (D) papilla on hind wing, and (E) hind tarsus; (F) head and antenna, and (G) cauda of apterous ♀; (H) hind leg of oviparous ♀.

Aphis tavaresi, Del Guercio (The Black Citrus Aphis). (Figs. 6, 15.)

Del Guercio, Broteria, vii, p. 143, pl. xvi, figs. 1 & 2 (1908).

Alate viviparous female.—Dark brownish to black; cornicles and cauda black; antennae dark brown with two pale bands; legs with dark femora and a dark band at the base and apex of the tibiae and dark or paler tarsi. Wings with yellowish brown veins and pale yellowish brown stigma. Head flat, with a pale median round spot, slightly raised at the base of the antennae, with four pale fine

hairs in front; antennae not as long as the body, the first three segments dark brown, the fourth and fifth with a broad pale band on the basal half, sixth brown, the first segment is wider and slightly longer than the second; the third the longest, with from 10 to 14 sensoria showing marked double contour lines, along the whole length of the segment, and with five prominent pale brown hairs on one side, and three on the other side, imbricated; fourth segment slightly shorter than the third, showing one sensorium in the middle; fifth shorter than the fourth, with a large subapical sensorium; sixth slightly longer than four and five, with one large and six small sensoria at the base of the flagellum; all the segments imbricated and with a few hairs. Eyes dark. Rostrum pale at base, dark at apex, with a few hairs, reaching to the second pair of legs or a little beyond. Cornicles black, moderately long and thick, slightly expanding basally, imbricated along their whole length. Cauda black, about half the length of the cornicles, bluntly rounded at the apex, with many long thin pale hairs. Legs moderately long, femora rather thick and dark, tibiae long and narrower, with a narrow dark band at the base and a wider one at the apex; tarsi dark, of two segments, hairy, imbricated. Wings with yellowish brown veins and stigma, some browner than others, longer than the body. *Length* 1·6 to 2 mm.

Apterous viviparous female.—Dark brown; two basal segments of antennae dark brown, rest paler brown, third segment the palest. Legs with dark femora, tibiae widely black at the apex, tarsi black, legs shorter and thicker than in the alate female, hairy. Cauda and cornicles dark. Antennae not quite as long as the body; the first segment wider and longer than the second, which is partly sunk into it; the third slightly longer than the fourth; the fourth slightly longer than the fifth; the sixth slightly longer than four and five: a single sensorium near the apex of the fifth and one large and six small at the base of the flagellum; all the segments imbricated, and each with a few hairs. Cauda rather more than half the length of the cornicles, with many long fine pale hairs; cornicles black, imbricated. Head convex, with several long pale hairs. A lateral tubercle on each side of prothorax and five (6?) pairs of small short dark tubercles behind. Cuticle with hexagonal ornamentation. A few hairs on the body. *Length* 1·5 mm.

Oviparous female (?).—Similar to the foregoing, but the third, fourth and fifth antennal segments pale. Legs similar, but the posterior tibiae much thickened; head slightly convex. *Length* 1·10 to 2 mm.

Nymph.—Similar to apterous female, but the cauda shorter and the wing-buds dark. Head slightly rounded in front.

PORTUGUESE EAST AFRICA: Zambezia (*Tavares*); NYASALAND: Blantyre, vi. 1910 (*Dr. J. E. S. Old*); BRIT. EAST AFRICA: Njoro (*T. J. Anderson*); ZANZIBAR: 3. iii. 1911 (*Dr. W. M. Aders*).

FOOD-PLANTS: Citrus trees and Cotton.

Del Guercio describes and figures a black citrus aphis from the Zambesi region as *Aphis tavaresi*, but the description is not at all full. However the general appearance of the citrus aphides sent from Blantyre and Njoro agree so closely that I feel sure they must be the same species. The figures given by Del Guercio do not seem normal, the cornicles are much constricted at the apex; this occurs in some few of the spirit specimens I have seen. The species is

undoubtedly subject to much variation in colour and in the relative length, thickness and form of the cornicles in both apterae and alatae, but the structural characters given here are the same in all. One or two show pale cornicles and pallid tarsi, as figured by Del Guercio, but the majority have black tarsi. The hexagonal sculpturing of the cuticle is very marked. Several forms sent have thick hind tibiae, and these are evidently oviparous females, although they have no sensoria. Apterae sent from Zanzibar from cotton are clearly the same species.

In spite of the different form of the cornicles figured by Del Guercio there seems no reason to doubt the identification. Lounsbury records a black aphis on oranges at the Cape. It may refer to this species or to *Toxoptera aurantiae*, which occurs with it. Lounsbury speaks of it as *Siphonophora* sp.? (Leaflet no. 2, Dept. Agric. Cape Col. 1896) and states that it is preyed upon by *Chilomenes lunata*.

It lives beneath the leaves and on the shoots and blossoms, causing the leaves to curl up and become much deformed.

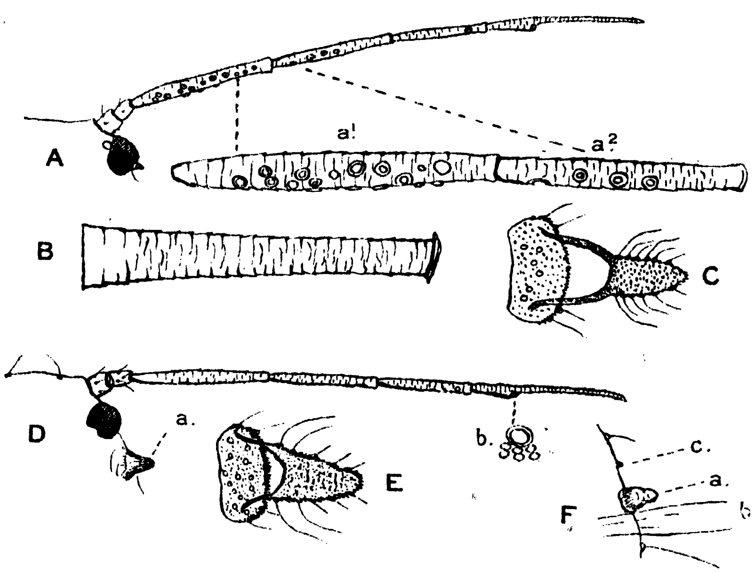


Fig. 7.—*Aphis solanella*, Theo.; (A) head and antenna, (B) cornicle, and (C) cauda of alate ♀; (D) head and antenna of apterous ♀, (*a*) prothoracic papilla, (*b*) sensoria on 6th segment; (E) cauda of apterous ♀; (F) large papilla (*a*) in front of third leg (*b*), with small anterior papilla (*c*).

Aphis solanella, sp. nov. (Figs. 7, 8.)

Alate viviparous female.—Head black; antennae not as long as the body, the two basal segments and the sixth dark, especially the two first, the third segment a little longer than the fourth, the fourth a little longer than the fifth, the third with 16 to 18 sensoria scattered over its whole length, the fourth with 0–4 sensoria. Eyes black. Proboscis dusky at the apex. Pronotum yellowish green; thorax black. Abdomen green to greenish brown, with dark median cross-bars, four black lateral spots and a prominent one between or just caudad

of the cornicles, which have a dark spot at their base; one large and one small lateral blunt tubercle on each side before the cornicles, and a large one between them and the cauda. Cornicles short thick, black, strongly imbricated, slightly expanded basally; anal plate black; cauda prominent, black apically, with many pale hairs curved apically. Legs greenish, with dark apices to the femora and tibiae, and dark tarsi. Wings with yellowish brown insertions, brown stigma and veins. Venter of head brown; of thorax dark brown; of abdomen green, except for a brown anal plate and traces of basal narrow dark bands. *Length* 1·5 mm., wing expanse 7 mm.

Apterous viviparous female.—Head and thorax black; antennae shorter than the body, the two basal segments black, also the sixth, remainder of antennae greenish, in some specimens the tip of the fifth being dusky; the third segment is longer than the fourth, the fourth a little longer than the fifth. Pronotum with a prominent blunt spine on each side. Abdomen brownish green, with small

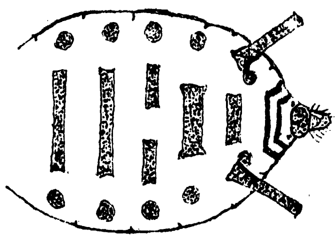


Fig. 8.—*Aphis solanella*, Theo.; abdomen of alate ♀.

black lateral spots in depressions on each side, one large anterior blunt process on each side, a smaller one behind and a large one between the cornicles and cauda. Cornicles black, expanded basally, imbricated. Cauda black, spiny, with numerous pale hairs curved apically; anal plate dark. Legs greenish, apices of tibiae and the tarsi dusky to black. Venter deep brownish green; coxae and anal plate black. *Length* 1·7 to 2 mm.

British East Africa: Njoro, i. 1913 (*T. J. Anderson*).

Food-plant: *Solanum* sp.

This species somewhat resembles Koch's *Aphis rhei* from rhubarb, but is certainly distinct. One alate female shows four sensoria on segment four and another three, the majority none. So far as I can see from the material sent, the lateral abdominal tubercles are marked. The colours given are taken from alcohol specimens. The marked antennal ornamentation of the alate female will at once séparate it from allied species.

Aphis persicae, Boyer (The Black Peach Aphis).

Aphis amygdali, Buckton.

Boyer, Ann. Soc. Ent. France, x, p. 175 (1841); Buckton, Mon. Brit. Aph. ii, p. 104, pl. lxxiii, figs. 1–5 (1877); Lounsbury, Leaflet no. 28, Dept. Agric. Cape Col. (1906).

Cape Colony: midland and northern districts (*Lounsbury*); Natal (*Fuller*); Transvaal: Pretoria, 1. viii. 13 (*G. Bedford*).—Europe, N. America and Australia.

FOOD-PLANTS: Peach and Nectarine.

This is the so-called Black Peach Aphis which has been spoken of as *Myzus persicae* in the Cape and Natal. *Myzus persicae*, Sulzer, is a greenish and pinkish aphis and may be the one mentioned by Lounsbury as occurring along the Orange River (Leaflet no. 33, Dept. Agric. Cape Col. 1908). I have received *Aphis persicae* from Pretoria with much-curled peach leaves and these specimens agree exactly with the European species.

Schouteden places Koch's *farfarae* as a doubtful synonym. I think they are quite distinct.

Referring to the Black Peach Aphis, Lounsbury (Leaflet no. 2, p. 15, 1896) says that the majority are parasitised by a minute Hymenopteron and that Syrphid larvae cleared them off in transit. I only found one parasitised specimen amongst the large number sent from Pretoria. French records *Myzus cerasi* as the Black Peach Aphis of Australia; it is evidently this species (Handbk. Dest. Ins. Victoria, ii, p. 9. pl. xvi.)

Aphis ligustriella, sp. nov.

Apterous viviparous female.—Green; head darker; cornicles dark brown to black; base and apex of antennae brown; legs with dark apex to tibiae and dark tarsi; cauda dark. Antennae shorter than the body; first segment broader and longer than the second, third the longest, fourth and fifth about equal, sixth as long as the fourth and fifth, the basal portion about half as long as the flagellum; the segments all imbricated. A lateral papilla on each side of the pronotum and

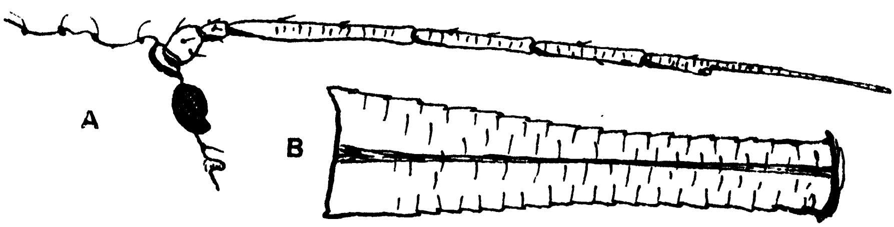


Fig. 9.—*Aphis ligustriella*, Theo., apterous ♀; (A) head and antenna; (B) cornicle.

a smaller one between the second and third pairs of legs. Cuticle of body with reticulate sculpturing. Cornicles black, of moderate length, thick, expanding towards the base, imbricated. Cauda shorter than the cornicles, deep brown to black, with three pairs of lateral hairs; anal plate black. Legs moderately long, apex of tibiae and the tarsi blackish, femora and tibiae with short hairs. *Length* 1·3 to 1·5 mm.

TRANSVAAL: Pretoria, 1. viii. 13 (*G. Bedford*).

FOOD-PLANT: Privet.

Described from two adult apterous females and many immature forms. The cuticular ornamentation and the lateral papillae distinguish this species, with its dark thick cornicles and black cauda.

Aphis nigripes, sp. nov.

Apterous viviparous female.—Head brown; eyes black. Pronotum and thoracic lobes yellow. Abdomen yellow, with five small black specks on each side.

Antennae dark; base of third segment pale; legs black; anal plate and cauda black. Antennae a little more than half the length of the body; first segment wider than, but of the same length as, the second, both black; third segment the longest, basal half pale, all the rest of the antennae dark brown to black; fourth segment a little longer than the fifth; fifth with a subapical sensorium; the sixth shorter than four and five together, its basal area about half the length of the fifth; all the segments imbricated and with a few short, stiff hairs. Head with a few fairly long hairs. Proboscis reaching to the third coxae, thick, dark at the apex. Pronotum with a small pale lateral blunt papilla, another about the level of the third pair of legs, and another between the cornicles and cauda. Cornicles jet-black, thick, expanding basally, prominently and closely imbricated. Cauda prominent, rather less than half the length of the cornicles, with seven pairs of lateral hairs; anal plate black, spinose, with several apical lateral hairs. Cuticle of abdomen reticulate, a few hairs over the surface. Legs black, moderately long and rather thick. *Length* 2 to 2·3 mm.

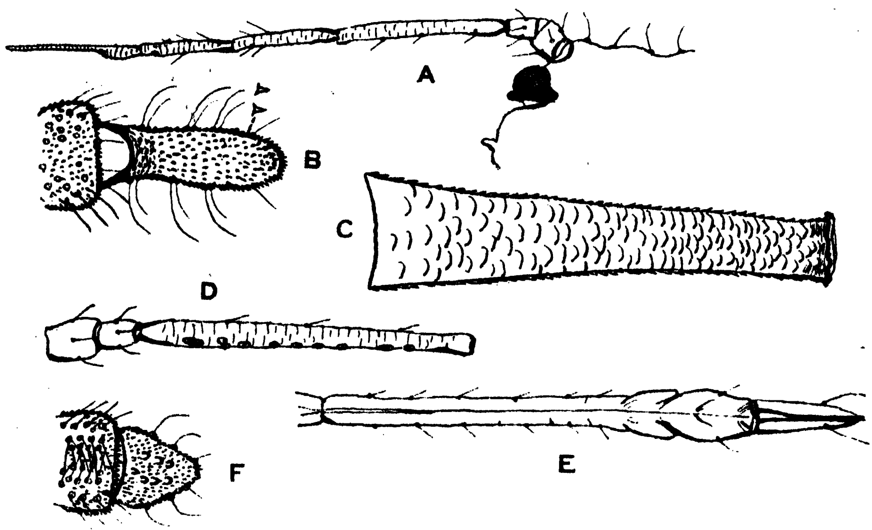


Fig. 10.—*Aphis nigripes*, Theo.; (A) head and antenna, (B) cauda, and (C) cornicle of apterous ♀; (D) base of antenna, and (E) proboscis of alate ♀; (F) cauda of nymph.

Alate viviparous female.—Head brown; eyes black. Pronotum yellow; thoracic lobes black. Abdomen citron yellow, with three black spots and three pairs of smaller dark specks interior to them on each side; a large black spot behind the base of the cornicles. Antennae dark. Cornicles, cauda and anal plate black. Legs black. Wings with yellowish brown veins and yellow insertions. Antennae with the first segment wider and longer than the second; the third with eleven to twelve sensoria along one side, the two basal ones united, imbricated and with a few short hairs. Proboscis not quite reaching the third pair of legs, thinner than in the apterous female, the last two segments dark, the rest pale. Metanotum and metasternum black. Cauda black, curved upwards, with three pairs of lateral hairs, a little more than half the length of the cornicles; anal plate black, with many hairs. Cornicles black, cylindrical, slightly expand-

ing at the base, markedly and closely imbricated. Legs black, base of femora pale. Wings with yellowish brown veins and stigma, and yellow insertions. *Length* 2 to 2·3 mm.

Nymph.—With rather thicker and shorter black legs, dusky wing-cases and short dark bluntly triangular cauda, with three pairs of lateral bristles; anal plate dusky, with many long chaetae, the inner group crossing one another. Four dark spots show on the pronotum, and the middle of the mesonotum is dusky in front. *Length* 1·8 to 2·3 mm.

TRANSVAAL: Pretoria, 1. viii. 13 (*G. Bedford*).

FOOD-PLANT: Willow (*Salix* sp.).

Described from a number of spirit specimens, which unfortunately were nearly all damaged, except the nymphae; there were only four alate females and none of these had complete antennae. A very marked yellow species, with prominent black legs, cornicles, cauda and antennae.

Aphis coffeae, Nietner.

Morstatt, Der Pflanzer, Dar-es-salaam, ix, p. 298 (1913).

GERMAN EAST AFRICA (*Morstatt*).

FOOD-PLANT: Coffee.

Aphis rumicis, Linnaeus (Black Fly or Collier).

Aphis papaveris, Fabricius.
Aphis thlaspeos, Schrank.
Aphis fabae, Scopoli.
Aphis atriplicis, Fabricius (*nec* Linnaeus).
Aphis aparines, Schrank.
Aphis armata, Hausmann.
Aphis dahliae, Mosley.
Aphis evonymi, Fabricius.
Aphis ulicis, Fabricius.

Linnaeus, Syst. Nat. i, 2, pp. 724, 735 (1767); Theobald, J. Bd. Agric., London, xix, pp. 467–476, pl. ii, fig. 1 (1912); Morstatt, Der Pflanzer, Dar-es-salaam, ix, p. 296 (1913).

GERMAN EAST AFRICA (*Morstatt*).—Europe generally, N. America and India.

Morstatt records it from cowpeas in Africa. For a full list of food-plants, life-cycle and references, see my paper in the Journal of the Board of Agriculture. Two new food-plants must be added to the list I have previously given, namely, *Vigna catjang* and *Benincasa cerifera*, in India (Lefroy).

Aphis (Myzus) nerii, Boyer.

Aphis asclepiadis, Passerini.

Boyer, Ann. Soc. Ent. France, x, pp. 179–180 (1841); Passerini, Aphid. Ital., pp. 22, 25 (1863); Ferrari, Aphid. Liguriae, p. 62 (1872).

EGYPT: Cairo (*F. C. Willcocks*).

FOOD-PLANTS: Oleander (*Nerium oleander*), *Asclepias cornuti*, *Asclepias grandiflora* and *tuberosa*, and *Citrus aurantii*.

Aphis africana, sp. nov.

Alate viviparous female.—Head brown; thoracic lobes deep brown to black; abdomen of various shades of green, with dark marks at the sides; antennae, legs, cornicles and cauda deep brown to black. Antennae shorter than the body; first segment broader, but scarcely longer than the second; the third the longest, with 13 to 20 sensoria scattered over it, thicker than the following; the fourth about half the length of the third, with 0 to 4 sensoria; the fifth about as long as the fourth, or slightly shorter, with a subapical sensorium; the sixth with the basal area nearly as long as the fifth and the flagellum not quite twice its length; all the segments imbricated and with a few short hairs. Head nearly flat, with a central tubercle in front, and four hairs on the vertex. Eyes large, black and red. Cornicles rather short, black to deep brownish black, in some specimens cylindrical, in others slightly swollen in the middle, imbricated. Cauda not quite as long as the cornicles, black, rounded apically, with several rather long pale hairs; anal plate large, rounded, black, with long hairs. Legs moderately thick, uniformly dark brown to black, with numerous short hairs. Wings large, with brown veins and stigma. Proboscis short and thick, reaching to about the second coxae. *Length* 1·5 to 2 mm.

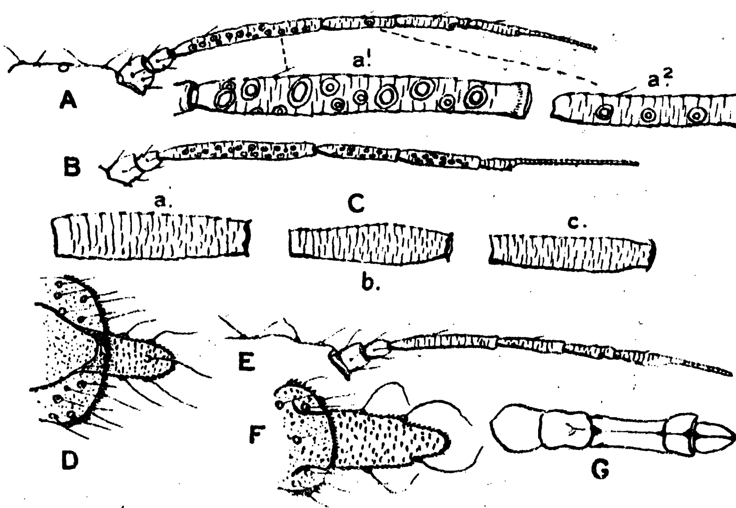


Fig. 11.—*Aphis africana*, Theo.; (A) antenna of alate ♀; (B) antenna of *A. avenae*, F.; (C) cornicles, and (D) cauda of alate ♀; (E) antenna, (F) cauda, and (G) proboscis of apterous ♀.

Apterous viviparous female.—Green of various shades, head darker in front, almost flat in some examples, slightly projecting in the middle in others, with four hairs in front. Eyes large, black and red. Antennae considerably shorter than the body, brown, the third segment paler; basal segment longer and broader than the second, both dark; the third ~~the~~ longest; fourth rather more than half the length of the third; fifth about equal to it, with a subapical

sensorium ; sixth short, about as long as four and five ; basal process rather more than half the length of the flagellum, with a group of sensoria at its apex ; all the segments imbricated and with a few hairs. Legs usually deep brown to black, but a few seem to have paler legs, thicker than in the alatae and not quite so long, hairy. Proboscis short and thick, dusky at the apex, reaching the second coxae. Cornicles black, imbricated, rather short, sometimes cylindrical, or slightly expanded basally, or else expanded in the middle or towards the apex. Cauda and anal plate black, hairy and spinose, hairs rather long and pale. *Length* 1·2 to 1·5 mm.

Nymph.—Paler than apterous females, but with brown legs, black cornicles and black rounded cauda, wing-cases greenish ; head brown. Antennae with third and fourth segments paler. Proboscis short and thick, dusky at the apex, not quite reaching the second coxae. *Length* 1·5 to 1·8 mm.

BRITISH EAST AFRICA : Njoro, i. 1912 (*T. J. Anderson*).

FOOD-PLANTS : Broom Corn and Barley.

I at first took this insect to be the European and American *Aphis* (*Siphocoryne*) *avenae* but I now think it must be distinct. The antennae of the alate females do not agree ; in *avenae* the third to fifth segments are usually provided with sensoria, there are none on the fifth in *africana* and none to very few on the fourth. Moreover in *avenae* the legs are not all black as in *africana* ; and in the apterae of the latter only the third segment of the antennae is pale, whereas in *avenae* the first three segments of the antennae are pale, and the nectaries are pale with a dusky apex, while the exserted tail is more than half the length of the cornicles.

But as Pergande says (Bull. 44, U.S. Dept. Agric. Div. Ent. p. 10, 1904) that there is some variation in the tuberculation of the antennae and as undoubtedly pale-legged varieties occur in Africa, it is possible that this is only a variety of *avenae*. There are also marked differences in the cornicles of this species from those of *A. avenae* off corn received from America or found by me in England ; but they resemble the cornicles of the form found on apples in Europe. I hope to deal fully with this species at a future date.

Myzus persicae, Sulzer.

Sulzer, Abg. Gesch. Ins. p. 105, pl. ii, figs. 4 and 5 (1776).

This species has been recorded as the Black Peach Aphis by Lounsbury and Fuller.

As pointed out, the Black Peach Aphis is *Aphis persicae*, Boyer, and all records of the *Myzus* evidently refer to that species.

Myzus cerasi, Fabricius.

Fuller records *Myzus cerasi*, F., from Natal (Second Report Gov. Ent. 1901, p. 27, 1902) as the Black Peach Aphis. Evidently this is *Aphis persicae*, Boyer.

Hyalopterus pruni, Fabricius. (The Mealy Plum Aphis.)

Hyalopterus arundinis, Fabricius.

Hyalopterus phragmiticola, Oestlund.

Fabricius, Sp. Ins. ii, p. 385 (1781); Kaltenbach, Mon. Pflanz. pp. 52, 54, (1843) ; Koch, Die Pflanz. p. 21, figs. 27–30 (1857) ; Buckton, Mon. Brit. Aph. ii, pp. 110–111, pl. lxxv, figs. 1–5 (1877).

EYGPT : Cairo (*F. C. Willcocks*).—Europe generally.

FOOD-PLANTS : *Prunus* spp. and various Rushes (*Arundo*).

Specimens sent me by Mr. Willcocks exactly agree with British examples. The species appears to be common on rushes and plums in and near Cairo.

Toxoptera theobromae, Schouteden. (The Cocoa Aphis.) (Figs. 12, 15.)

Schouteden, Ann. Soc. Ent. Belg. p. 38 (1906).

S. NIGERIA (*A. D. Peacock*); KAMERUN: Moliwe, Mabeta, Victoria and Bibundi (*Busse*); FRENCH CONGO (*Heim*); UGANDA: Kampala, 1. vii. 12 (*C. C. Gowdey*).

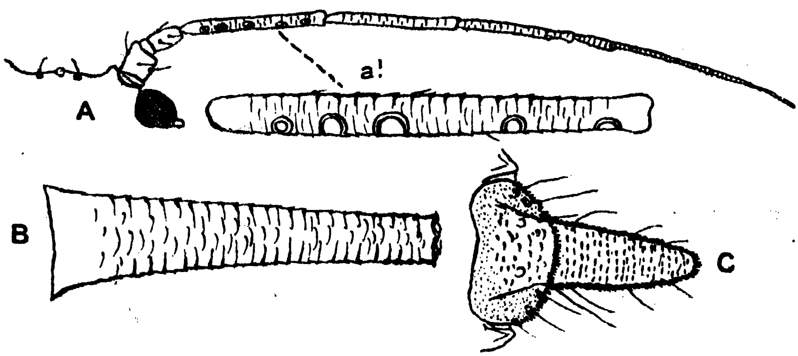


Fig. 12.—*Toxoptera theobromae*, Schout., alate ♀; (A) head and antennae; (B) cornicle; (C) cauda.

FOOD-PLANT: Cocoa (*Theobroma cacao*).

This appears to be the common Cocoa aphis in Africa. I believe it is also found in the Belgian Congo.

Toxoptera aurantii, Boyer. (The Black Citrus Toxoptera.) (Figs. 13, 14.)

Boyer, Ann. Soc. Ent. France, (1) x, p. 178 (1841).

NYASALAND: Blantyre, vi. 1910 (*Dr. J. E. S. Old*); BRITISH EAST AFRICA: 16. i. 12 (*T. J. Anderson*).—Southern Europe and India.

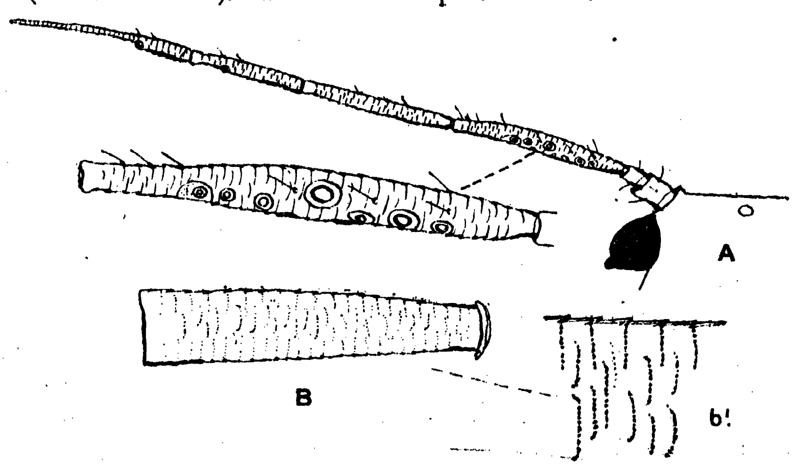


Fig. 13.—*Toxoptera aurantii*, Boyer, alate ♀; (A) head and antennae; (B) cornicle; (b^1) surface of cornicle.

FOOD-PLANTS : All Citrus trees.

I cannot separate this African Citrus species from the one I have found in Europe (described by Boyer de Fonscolombe in 1841) on oranges in boxes in September and in greenhouses in April. Its native home is at present unknown. Schouteden places Kaltenbach's *Aphis camelliae* (Mon. Pflanz. p. 122) as a synonym of this species. I do not think it is the same. Kaltenbach records it from *Camellia japonica* and Schouteden from Camellias in Brussels (Mem. Soc. Ent. Belg. xii, p. 230, 1906).

Boyer describes the abdomen of the alate female as having the sides green above and the short cornicles greenish with black apices. In *Aphis camelliae* the abdomen is brown and the cornicles are moderately long and black. Koch's *Toxoptera aurantiae* (Die Pflanz. p. 254, figs. 329, 330) from pomegranates has also brown cornicles and a brown body and may possibly be Kaltenbach's *camelliae*, but I am sure it is not Boyer's Citrus species.

Buckton's genus *Ceylonia* (Indian Museum Notes, ii, p. 35) is clearly the same as *Toxoptera.*

Toxoptera graminum, Rondani. (The Southern Grain Louse.) (Fig. 14.)

Aphis graminum, Rondani.

Rondani, Nuovi Ann. Soc. Nat. Bologna, (3) vi, p. 10 (1852); Mazzanti, Nuovi Ann. Soc. Nat. Bologna, (3) vi, pp. 342–352 (1852); Passerini, Bull. Soc. Ent. Ital. iii, pp. 151, 248, 340, 343 (1860); Passerini, Aphid. Italicae, p. 28 (1863); Horvath, Rovartani Lapok, i, pp. 143–145 (1884); Sajo, Zeits. für Pflanzenk. iv, p. 4 (1894); Horvath, Fn. Reg. Hungariae, p. 60 (1897); Del Guercio, Nuove Rel. R. Staz. Ent. Agraria, Firenze, (1) ii, p. 145 (1900); Pergande, Bull. no. 38 n. ser., U.S. Dept. Agric. Div. Ent. pp. 7–19, pl. i (1902).

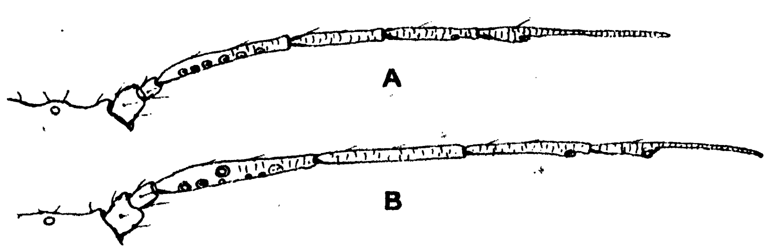


Fig. 14.—Antennae of alate ♀ of (A) *Toxoptera graminum*, Rond., and (B) *T. aurantii*, Boyer.

BRITISH EAST AFRICA: Njoro, i. 1912 (*T. J. Anderson*).—Southern and Central Europe and North America.

FOOD-PLANTS : Wheat, Barley and Broom Corn in Africa; Oats, Spelt (*Triticum spelta*), Couch grass (*T. repens*), *Hordeum marinum*, Soft Cheese (*Bromus mollis*), Corn (*Zea mais*), *Sorghum*, *Dactylis glomerata*, *Lolium perenne.*

This aphid, which appears to be mainly found on Graminaceae, is very destructive in parts of East Africa, as well as in Europe and in North America, where it is known as the Southern Grain Louse.

T. J. Anderson (Ann. Rept. Dept. Agric. Brit. E. Africa for 1911–12, p. 115) says that this species was responsible for considerable damage to the wheat crop at Njoro from June to November, 1911. He speaks of it as the Wheat Aphis or Wheat Green Fly.

Tuberculatus quercus, Kaltenbach.

Aphis quercus, Kaltenbach.
Aphis suberis, Tavares.
Callipterus quercus, Koch, Buckton, etc.
Myzocallis quercus, Passerini.

Kaltenbach, Mon. Pflanz. p. 98 (1843); Ratzeburg, Forst. Ins. iii, p. 217 (1844); Walker, Ann. Nat. Hist. (2) i, p. 337 (1848); Koch, Die Pflanz. p. 218, figs. 290, 291 (1857); Buckton, Mon. Brit. Aph. iii, p. 21, pl. xc (1880); Theobald, Sec. Rept. Econ. Zool. Brit. Mus. (N.H.), p. 122 (1902); Lounsbury, Leaflet no. 26, Dept. Agric. Cape Col. (1903).

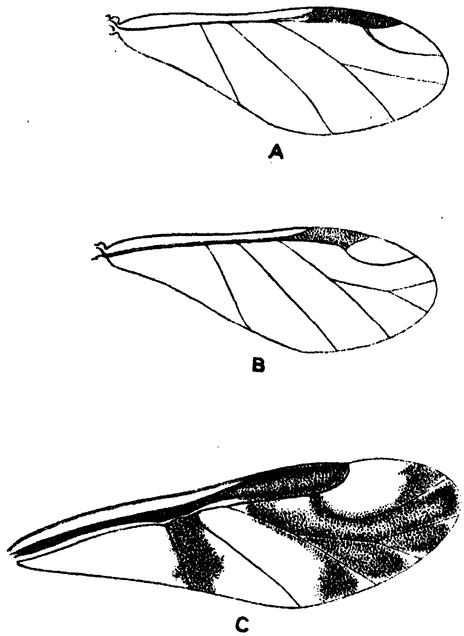


Fig. 15.—Fore wing of (A) *Toxoptera theobromae*, Schout., (B) *Aphis tavaresi* Del Guercio, and (C) *Dryaphis persicae*, Chol.

CAPE COLONY (*Lounsbury*).—Europe generally.

FOOD-PLANTS: *Quercus pedunculata*, *Q. sessiliflora*, *Q. ilex*, *Castanea pumila*.

Widespread and abundant at the Cape and considered by Lounsbury to be a chance introduction from Europe.

Dryaphis persicae, Cholodkovsky. (Figs. 15, 16.)

Lachnus persicae, Cholodkovsky.

Cholodkovsky, Zool. Anz. p. 472 (1899).

UPPER EGYPT (*Dr. L. H. Gough*).—Russia.

FOOD-PLANTS: Peach, Apple, Apricot, Pear and Plum.

Dr. Gough says that this beautiful Aphid seems confined to Upper Egypt. There is great variation in the length of the proboscis in the larvae sent by him. The marked wing ornamentation will separate it from other African Aphides so far known. The neuration of the genus *Dryaphis*, formerly called *Dryobius*, is very distinct from that of *Lachnus*. All the species have ornamented wings.

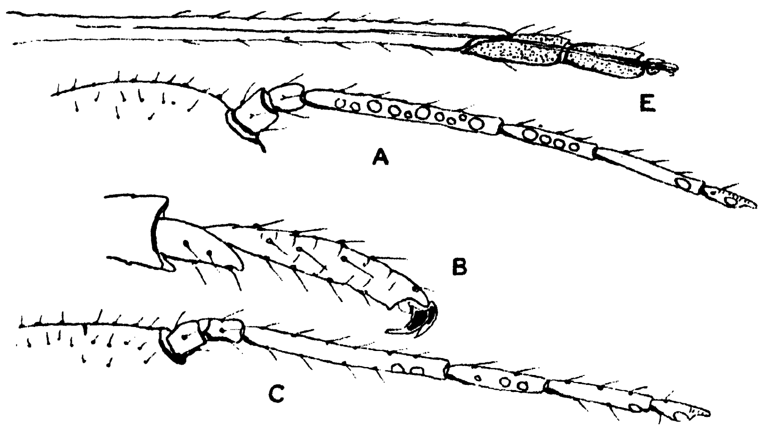


Fig. 16.—*Dryaphis persicae*, Chol.; (A) head and antenna; (B) hind tarsus of alate ♀; (C) head and antenna of apterous ♀; (E) proboscis of larva.

Lachniella thujafolia, sp. nov. (Fig. 17).

Apterous viviparous female.—Fawn-coloured, brown or greenish brown, sometimes orange-brown behind. Head darker, and sometimes the pronotum also; two divergent dark lines of spots in the front part of the abdomen and two rows of dark lateral specks, apex dark, with dark hair, almost black. Antennae pale, dusky at the apex and on the apex of the penultimate segment: the fifth segment is also sometimes dark. Legs fawn-coloured, pale, tarsi and apex of the tibiae deep brown, base and apex or only the apex of the femora dark, coxae dark. Antennae rather short; the first two segments about equal in length, the first somewhat the broader; the third the longest, equal to about the fourth and fifth which are either equal in length, or the fifth a little longer than the fourth, the latter with a large sensorium at the apex; the sixth equal to or slightly longer than the fifth, dark except just at the base, with a very short blunt nail, a large sensorium at its base and two smaller ones below; all the segments hairy, the hairs especially long on the third to the fifth. Proboscis long and thin, very acuminate, apex dark, reaching beyond the third pair of legs. Eyes large, dark. Abdomen with short hairs all over; cauda rounded, black, with black hairs; seven dark spots surround the spiracles, with smaller ones between; cornicles short, slightly elevated and conical, surrounded by a dark area. Legs moderately long, rather thick, apex of the tibiae and the tarsi dark, hairy, hairs densest and longest on the outer side of all the segments. *Length* 2 to 2·3 mm.

TRANSVAAL: Onderstepoort, 6. iv. 13, and Pretoria, 1., viii. 13 (*G. Bedford*); NATAL (?) (*Fuller*).

FOOD-PLANT: *Thuja orientalis.*

Described from a number of apterae and nymphae sent me by Mr. Gerald Bedford. I can find no described Lachnid from Thujas similar to it. In the young forms the colour seems paler and the proboscis may project beyond the

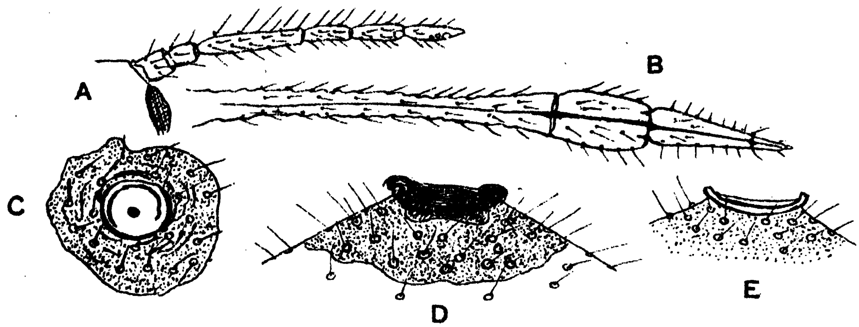


Fig. 17.—*Lachniella thujafolia*, Theo., apterous viviparous ♀; (A) antenna, (B) proboscis, (C) dorsal view of cornicle, (D) lateral view of cornicle; (E) cornicle of immature ♀

body. The nymphae generally resemble the apterous females, but the fifth antennal segment is markedly longer than the fourth and quite as long as the sixth.

This is probably the aphid that Fuller refers to as being common on the hedges of *Thuja orientalis* in Natal.* Mr. Bedford says it seems to be common in the Pretoria district.

Eriosoma lanigerum, Hausmann (Woolly Aphis).

Aphis (*Schizoneura*) *lanigera*, Hausmann.
Coccus mali, Bingley.
Eriosoma mali, Blot.
Schizoneura americana, Riley.
Schizoneura pyri, Fitch.

Hausmann, Illig. Mag. i, p. 440 (1802); Bingley, Anim. Biog. iii, p. 200 (1803); Samouelle, Entom. Compend. p. 232 (1819); Blot, Mem. Soc. Linn. du Calvados, i, p. 114 (1824), and Mem. Soc. Agric. de Caen, 1831, p. 58; Kaltenbach, Mon. Pflanz. p. 169 (1843); Riley, Bull. U.S. Geol. & Geog. Survey, v, pp. 4–9 (1879); Buckton, Mon. Brit. Aph. iii, p. 89, pl. cv and cvi, figs. 1–5 (1880); Lounsbury, Leaflet 2, p. 10. Dept. Agric. Cape Col. (1896), Theobald, Insect Pests of Fruit, p. 141, figs. 116–126 (1909).

CAPE COLONY (*Lounsbury*)†; NATAL (*Fuller*)‡; BRITISH EAST AFRICA (*Anderson*)§; ORANGE RIVER COLONY (*Dewar*)‖.—All countries where apple and pear are cultivated or found including Southern India where it is destructive (Buckton, Ind. Mus. Notes, ii, p. 52).

* First Rept. Gov. Ent. 1899–1900, p. 95 (1901).

† Rept. Gov. Ent. for 1896, pp. 107–114, fig. 24 and plate iii, (1897); ibid. for 1898, p. 46 (1899); Cape Agric. Journal, 12th Oct. 1899, p. 541.

‡ First Rep. Gov. Ent. 1899–1900, pp. 96–98 (1901).

§ Ann. Rept. Dept. Agric. B. E. Africa, p. 96 (1909).

‖ Farmers Bulletin no. viii, pp. 8–10 (1905).

FOOD-PLANTS: Apple, Pear and Quince; and Elm in North America.

Lounsbury records *Exochomus auritus* as feeding on this aphis in South Africa.

Common and at one time very destructive at the Cape, especially in the Eastern Section; it is also very destructive in Natal. It has been apparently introduced into British East Africa where its multiplication has been extremely rapid.* Dewar says "probably present in all districts of the Orange River Colony."†

Miss E. Patch has recently shown that in America the Woolly Aphis migrates between the elm and apple, etc. (Bull. 217, Maine Agric. Exp. Sta., Oct. 1913). In England this does not appear to be the case.

Rectinasus buxtoni, Theobald.

Theobald, The Entomologist, xlvii, p. 29, Jan. 1914.

EAST ALGERIA: Lambese, Batna, 5. iv. 13 (*Buxton* and *Gurney*).

Found in the nests of *Bothryomyrmex meridionalis* and *Pheidole pallidula*, and also in White Ants' nests (*Leucotermes lucifugus*, Rossi). Evidently a true myrmecophilous species.

Forda rotunda, Theobald.

Theobald, The Entomologist, xlvii, p. 30, Jan. 1914.

E. ALGERIA: Hammam, Meskontine, 3. iv. 13 (*Buxton*).

Found in ants' nests (*Tapinoma erraticum*).

Phylloxera corticalis, Kaltenbach.

Kaltenbach, Die Pflanzen-Feinde der Insecten, p. 677 (1874); Theobald, Second Report Eco. Zool. B.M (N.H.) p. 122 (1902); Lounsbury, Cape Agric. Journ., Dec. 1903.

CAPE COLONY: King Williams Town and George; TRANSVAAL.—Europe.

FOOD-PLANTS: *Quercus robur* and the South African Oak (*Q. pedunculata*).

This Aphis was sent to me by Mr. Lounsbury in 1902. It then appeared to be new to South Africa, where it was found infesting the bark of oaks in countless numbers. It was thought that it had probably been introduced.

Phylloxera vastatrix, Planchon (Vine Louse).

Aphis vitis viniferae, Scopoli.
Pemphigus vitifolii, Fitch.
Peritymbia vitisana, Westwood.
Dactylosphaera vitifolii, Shimer.

Scopoli, Ent. Carn. p. 389 (1763); Fabricius, Ent. Syst. iv, p. 220 (1794); Westwood, Gard. Chron. p. 687 (1869); Planchon, Ann. Agrom. i, p. 74 (1875): Fitch, First and Sec. Repts. Nox. Ins. N. York, p. 158 (1886).

This well known vine pest has done considerable damage to the vineyards in South Africa.

---

* Ann. Rept. Dept. Agric. B. E. Africa, p. 96 (1909).
† Farmers Bulletin no. viii, pp. 8–10 (1905).

A NOTE ON THE ACTION OF COMMON SALT ON THE LARVAE OF STEGOMYIA FASCIATA.

By J. W. Scott Macfie, M.A., M.B., Ch.B.,

West African Medical Staff.

(Plate XXXII.)

It has been pointed out by Graham* that measures designed to bring about the destruction of mosquito larvae may be divided into (*a*) measures intended to destroy the larvae, and (*b*) measures intended to destroy their food supply. He points out that very little attention has been paid to the second method, which entails an exact knowledge of the freshwater algae. Graham found that the suspended matter in water in which the larvae of *Pyretophorus costalis* were breeding could be precipitated by the addition of 3 per cent. of common salt, and that then the larvae became cannibalistic and destroyed one another. He considered that this phenomenon was due to the larvae being deprived of their natural food, the algae, which had been destroyed by the addition of salt. "In lesser concentration," he concluded, "salt appears to inhibit the growth of very young larvae, probably by diminishing the supply of food, but the development of fully-grown larvae appears to be hastened in a hypertonic medium, and they pass into and through the pupal stage with unusual rapidity."

The following experiments were undertaken with a view to determining to what extent the action of salt on mosquito larvae was due to the destruction of the natural food supply, and to what extent to the hypertonic nature of the solution. The larvae employed were those of *Stegomyia fasciata*. This species was selected both because its breeding places would be most easily treated with salt, should this substance prove of value as a larvicide, and on account of its importance in a country in which yellow fever is endemic.

Salinity of the Medium in which the Larvae were found.

At Lagos the larvae of *Stegomyia fasciata* are commonly found in water-pots and domestic utensils in the compounds of the native quarters of the town. A number of samples of water were obtained from this source, and an analysis was made of the amount of salt present in each. The percentage was found to vary considerably, ranging from 0·005% to 0·019% NaCl, and the average of six determinations was 0·012 % NaCl.

This figure was found to be considerably below that for the water of the Lagos lagoon at the same season (September). The salinity of the water flowing beneath the Iddo bridge, to the North of Lagos, was found to be 0·026% NaCl; whilst that at the Magazine bridge, considerably nearer the sea, was 0·112% NaCl.

Bull. Ent. Res. Vol. i, p. 51-52, 1910.

It may therefore be assumed as probable that the larvae of *S. fasciata* thrive best in a medium whose salinity is about 0·012 per cent. NaCl. In order to determine whether the higher percentage of salt present in the lagoon would prove injurious to them, three samples of water containing larvae from domestic utensils was selected, and salt was added to them until the salinity of each was 0·026, the same percentage as was found to be present in the lagoon water at the Iddo bridge. No perceptible action was observed on the larvae, which remained healthy and active during the succeeding four days. The percentage of salt in two of the samples was then raised to 0·112, as in the lagoon water under Magazine bridge. The larvae seemed to be affected somewhat by this degree of salinity, and tended to remain for long periods at the bottom of the jars. By the seventh day all those in the one sample were dead, and only one remained alive in the other. The last larva died on the eighth day.

Experiments with Solutions of 0·5 per cent. NaCl and upwards.

The foregoing preliminary experiments suggested that it might be of some interest to determine the effects of various strengths of salt solutions on the larvae of *S. fasciata*. In order to exclude the factor of precipitation, the experiments were in the first instance carried out in clean water.

For this purpose ten mature larvae were placed in each of six jars containing respectively 0·5 %, 1 %, 2 %, 3 %, 4 %, and 5 % NaCl solutions. The results of the experiments are shown in detail below :—

TABLE I.

NaCl.	0·5 %	1 %	2 %	3 %	4 %	5 %
Oct. 12, 11 a.m.	10 L.	10 L.	10 L.	10 L.	10 L.	10 L.
,, 1 p.m.	9 L., 1 P.	10 L.	9 L., 1 P.	10 L.	1 L., 9 dead L.	All dead.
,, 3 p.m.	9 L., 1 P.	10 L.	9 L., 1 P.	7 L., 3 dead L.	All dead.	
,, 5 p.m.	9 L., 1 P.	10 L.	9 L., 1 P.	6 L., 1 dead L.		
,, 11 p.m.	9 L., 1 P.	10 L.	9 L., 1 P.	All dead.		
Oct. 13.	7 L., 3 P.	7 L., 3 P.	8 L., 1 P., 1 dead L. Three larvae almost inert.			
Oct. 14 ...	6 L., 4 P.	7 L., 2 P., 1 M.	4 L., 1 P., 3 dead L.			
Oct. 15 ...	5 L., 2 P.. 3 M.	6 L., 3 M.	All dead.			
Oct. 16 ...	5 L., 2 P.	6 L.				
Oct. 17 ...	5 L., 2 M.	4 L., 2 dead L				
Oct. 18 ...	5 L.	4 L.				
Oct. 19 ...	5 L.	4 L.				
Oct. 20 ...	5 L.	3 L., 1 dead L.				
Oct. 22 ...	5 L.	1 L., 2 dead L.				

L = Larva, P = pupa, M = adult mosquito.

The effects of the different solutions on the larvae varied directly with their strengths. In 5 % NaCl all the larvae had died within two hours, in 4 % within four hours, and in 3 % within twelve hours. In 2 % NaCl solution all had died within three days ; in 1 % during the ten days for which the experiment was continued, five larvae died, four pupated and hatched, and one remained alive at

the conclusion of the observations. The lowest concentration, 0·5 % NaCl, seemed to have but little effect; five larvae pupated and hatched, and five remained alive at the end of the experiment; none died.

The rapidity with which the larvae were killed by the stronger solutions seems to prove that, at any rate as low as 2 or 3 % NaCl, the action on the mature larvae of *S. fasciata* is an osmotic one, and is not dependent on the destruction of algae, nor on the deprivation of the insects of their natural food supply.

The action of the salt solution is not, however, appreciably altered by the presence of débris, etc., as is proved by the following experiment. A large number of larvae and pupae in their natural medium were placed in a jar, and enough salt added to bring up the strength of the solution to 2 %. Six hours later many of the larvae were dead, and twelve hours after this all had perished. A number of the pupae hatched during the first two days, but on the third day all those that remained were dead.

Experiments with more dilute solutions of salt.

Although solutions of salt of 2 % and upwards appeared to produce an inimical effect on the larvae of *S. fasciata* by direct osmotic action, more dilute solutions in clear water had a much less pronounced effect. It was considered possible, however, that the latter solutions might cause a precipitation of the organic constituents of the natural fluid in which the mosquito larvae were found, and might thus kill, or at any rate inhibit the growth of, the larvae by depriving them of food as was suggested by Graham.

Mature larvae were therefore distributed into glass jars, and the salinity of the natural medium, which contained 0·012 % NaCl, was increased by the addition of salt to 0·10 %, 0·15 %, 0·20 %, 0·25 %, and 0·30 % respectively. Larvae were also introduced into a solution of 0·32 % NaCl in pure water for comparison. The results of these experiments are shown below.

TABLE II.

NaCl.	0·10 %	0·15 %	0·20 %	0·25 %	0·30 %	0·32 % in pure water.
Oct. 11.	20 L.	20 L.	10 L.	20 L.	20 L.	10 L.
Oct. 12.	17 L., 3 P.	13 L., 2 P., 5 dead L.	5 L., 1 P., 4 dead L.	9 L., 4 P., 7 died L.	9 L., 1 P., 10 dead L.	7 L., 1 P., 2 dead L.
Oct. 13.	11 L., 9 P.	9 L., 4 P., 2 dead L.	2 L., 3 P., 1 dead L.	4 L., 6 P., 3 dead L.	8 L., 2 P.	5 L., 3 P.
Oct. 14.	8 L., 12 P.	3 L., 9 P., 1 dead P.	5 P.	1 L., 7 P., 2 M.	2 L., 7 P., 1 M.	5 L., 3 P.
Oct. 15.	2 L., 9 P., 8 M., 1 dead P.	1 L., 8 P., 3 M.	2 P., 3 M.	4 P., 3 M., 1 dead L.	7 P., 1 M., 1 dead L.	3 M., 5 dead L.
Oct. 16.	1 L., 8 P., 2 M.	3 P., 3 M., 3 dead P.	2 M.	2 P., 2 M.	2 P., 5 M.	
Oct. 17.	3 P., 4 M., 2 dead P.	3 M.		1 M., 1 dead P.	1., M., 1 dead P.	
Oct. 18.	1 P., 2 M.					
Oct. 19.	1 M.					

L = Larva; P = pupa; M = mosquito.

It will be observed that during the first 24 hours the effect of the saline solutions in the natural medium, estimated by the death of the larvae, was proportional to the strengths of the solutions used. In the experiment with clear water the action was not marked until three days later. It is possible that the injurious effects in the former cases may have been due to the clogging of the tracheae of the larvae by precipitates. The deaths during the first 24 hours cannot at any rate be attributed to starvation.

All the larvae in these experiments had either died, or pupated and hatched, by the 9th day. The number that died was roughly in proportion to the strength of the saline solution. Thus in the 0·10 % solution none died as larvae, but in the 0·30 % eleven of the original twenty died in this condition.

NaCl.	0·10 %	0·15 %	0·25 %	0·30 %
Hatched	17	9	8	8
Died as pupae	3	4	1	1
Died as larvae	0	7	11	11

Very young larvae appeared to be more adaptable than mature larvae to a change in the concentration of the medium. Solutions containing 0·10 %, 0·20 %, and 0·30 % NaCl did not appear to have any appreciable effect on them.

Experiments with Alum Solutions.

If, as has been suggested, the inimical action of common salt on mosquito larvae is due to the precipitation of the minute algae on which they feed, it might be supposed that alum would have a more pronounced effect owing to its well-known clarifying action on impure waters. It was thought possible also that the gelatinous precipitate might interfere with the respiratory processes of the larvae, for it had been observed that in a pool containing innumerable larvae great numbers had died when some toad spawn was deposited in it. The spawn floated on the surface of the water and spread out like a veil, the eggs being connected by fine threads of mucus in which the mosquito larvae had become entangled and had died.

Three experiments were carried out in which potash alum was added to turbid water containing larvae so as to bring the strengths of the solutions up to 0·05 %, 0·10 %, and 0·20 % respectively. Ten mature larvae were used in each experiment.

The addition of the alum produced a copious precipitate which slowly settled to the bottom of the jars, but there was no immediate effect on the vitality or activity of the larvae. In the jar containing 0·05 % solution five larvae pupated and hatched, one larva died on the 7th day, and four that had pupated died on the third and fourth days. The last pupa hatched on the 12th day. Alum in this concentration appeared to have little or no direct effect. In the jar containing 0·10 % solution only one mosquito hatched, and the other nine larvae died between the third and the seventh days. In the third jar containing 0·20 % solution seven larvae died between the fourth and the seventh days, and three

that had pupated died on the third, fourth, and sixth days respectively. It was evident therefore that alum in these concentrations had no peculiar action on the larvae.

In more dilute solutions in clean water the results were inconclusive. Of ten mature larvae in a 0·01 % solution three pupated and hatched, and seven died as larvae ; in a 0·02 % solution exactly the same results occurred ; and in a 0·03 % solution two pupated and hatched and eight died as larvae. All had either hatched or died by the eighth, ninth, and tenth day respectively.

The action of a medium containing salt and alum in equal parts was tried in another series of experiments. The results, however, were similar to those obtained with a corresponding concentration of common salt alone.

Summary of Results.

The foregoing experiments would seem to prove that, in solutions of 2 % and upwards, the action of common salt on the larvae of *Stegomyia fasciata* is due to the hypertonicity of the solution. In more dilute solutions the destruction of the natural food supply of the larvae may have some influence. Alum, however, which clarifies water more efficiently than common salt, has no peculiar action on the larvae.

In Lagos the larvae of *Stegomyia fasciata* are found most abundantly in water contained in domestic utensils, and in the large pots in which the natives store up water for drinking and cooking. It would be of great advantage if common salt could be used as a larvicide in these cases ; for not only would the water not be rendered unfit for use in cooking, as it is by the application of kerosene, but also evaporation would tend to increase the strength of the larvicide, and repeated applications would be unnecessary. It would also be possible to keep stores of water in the compounds without danger. From the experiments described, it would appear that sufficient salt would have to be added to each vessel to bring the concentration of the solution up to 2 % NaCl in order to ensure the destruction of the larvae.

The Survival of Mosquito Larvae in Temporary Pools.

It often happens that small pools of water, such as those illustrated by the accompanying photographs (Pl. XXXII), collect beneath the taps of tanks and at the open ends of drains, and into these mosquito larvae are apt to be swept. Such pools soon dry up, the water seldom lying in them for more than an hour or two, and they may thus escape the attention of the Sanitary Inspectors. The soil round them is, however, permanently wet ; and if, as is usually the case, the pools are renewed once a day or more frequently by the tanks or drains being used, it is quite possible that mosquito larvae might develop in them. In some cases the finer soil washes away leaving a mass of irregularly-shaped stones in the interstices between which water may lie concealed all day long. Such pools may occasionally account for the presence of mosquitos in a house near which no breeding place can be located.

With a view to determining to what extent mosquito larvae were capable of surviving intermittent desiccation of this kind, the conditions obtaining under a

tank like that shown in Pl. XXXII. fig. 2 were reproduced in the laboratory by means of tins in the bottom of which small holes were pierced. The tins were half filled with soil and small stones, and an inch of water was added on the top. The drainage was arranged so that the surface of the soil became exposed after about one hour. The artificial pools thus formed were filled up every morning, and allowed to drain away as described. Thus a free surface of water was present for about one hour each day only. The soil, however, remained moist throughout the day.

Into such artificial pools pupae, mature larvae, and young larvae of *Stegomyia fasciata* were introduced. In the case of pupae the majority always hatched in the course of three or four days. In one experiment started with ten pupae, four had hatched within the first 24 hours, three more during the next 24 hours, and two more during the third day ; only one pupa perished. Mature larvae were found to be much less resistant to desiccation. They not infrequently pupated, but in our experiments none of the pupae hatched. Young larvae also survived only a short time, and did not undergo their normal development. Some of them however, remained alive until the sixth day ; and it is possible that had the pools been renewed more often, or allowed to persist a little longer, as no doubt they often do under natural conditions, the larvae might have matured, pupated and even hatched out into mosquitos.

The chief danger of such occasional pools therefore is that pupae, washed into them from other pools or from the gutters of bungalows, may complete their development in them. But as even immature larvae may also live for a number of days in such situations, it would perhaps be a wise precaution to treat these places with larvicides.

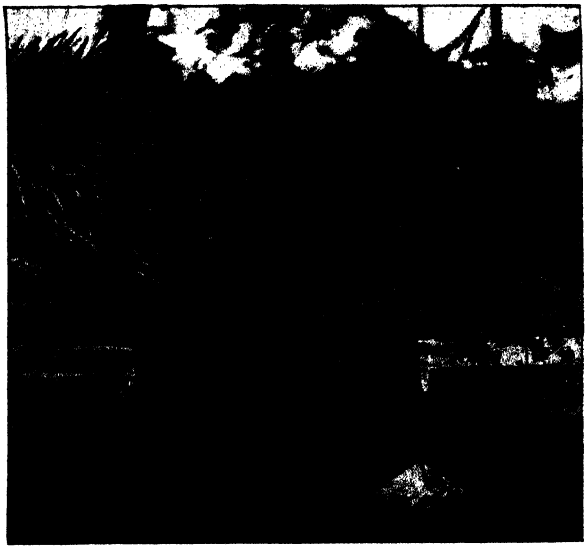


Fig. 1. Temporary pool at the open ends of a drain.

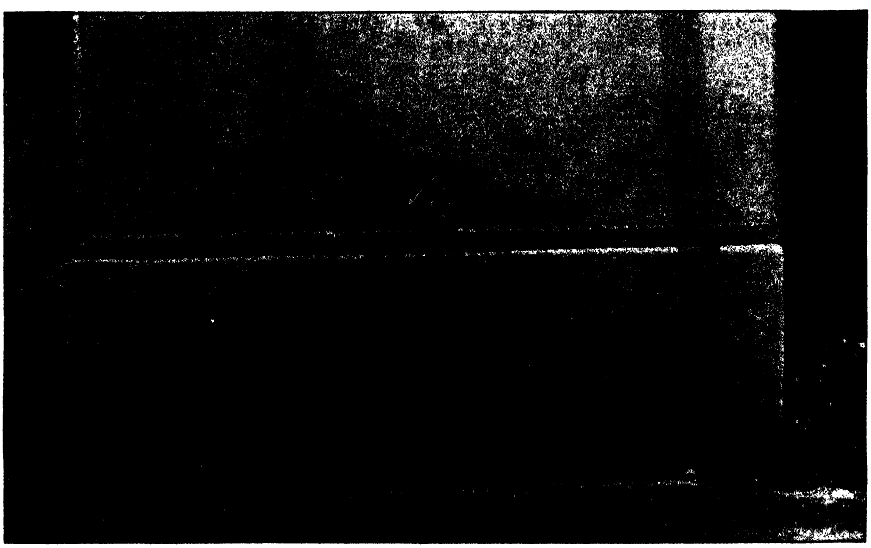


Fig. 2. Water-tank, showing the pools that collect under the tap.

BREEDING PLACES OF STEGOMYIA FASCIATA, LAGOS, S. NIGERIA.

THE TROPICAL BED-BUG, CLINOCORIS HEMIPTERA, FABR.

By the Hon. N. Charles Rothschild, M.A., F.E.S.

Dr. Horvath has recorded the fact that the bed-bug described under the various names, *hemiptera*, *rotundata*, *macrocephala* and *horrifer*, are all the same species, and that this insect must be termed *hemiptera*, as that is the oldest name. The insect in question is widely distributed over the tropics of both the Old and New World. The type specimen is still preserved in the Copenhagen Museum, and through the kindness of the authorities there I have recently been able to examine it, and can confirm Dr. Horvath's views. The type example of *Clinocoris foedus*, Stål, which was described from an example taken in Columbia, is in the Stockholm Museum, and was also submitted to me. This insect differs from *hemiptera* by having the lateral margin of the pronotum slightly but distinctly explanate and curved upwards. Whether this character is due to the shrinkage of the example, or whether it is really there, it is impossible to tell. In any case, should *foedus*, Stål, utimately prove to be the same as *hemiptera*, the name would simply form one more synonym of this species, though in all probability, when more material is discovered, *foedus* will be shown to be a distinct species.

A LIST OF THE MORE IMPORTANT INSECT PESTS OF CROPS IN THE NYASALAND PROTECTORATE.

By E. Ballard,

Government Entomologist, Nyasaland Protectorate.

The following paper gives a list of those insects of economic importance which have been collected or bred from various crops in Nyasaland during the first three months of the planting season 1911–12 and the whole of the season 1912–13. No attempt has been made to describe the various species mentioned, but their actual economic importance is stated in each case, so far as it has been possible to ascertain it during so short a period. All insects have been included as pests which have been found to feed on any particular crop in sufficient numbers to justify their inclusion in that category. In many cases the actual damage done may be slight, but at any time one or all of those species which feed regularly on crops may assume the position of dangerous pests, and so insects of apparently minor importance are included with those of definite and proved powers of destruction. The insects of first-class importance, which annually inflict heavy losses on the planters, are ten in number. These ten are confined to cotton, tobacco and maize, of which cotton is the worst sufferer, since it is attacked by a greater variety of insects than any other crop that has come under the writer's notice. Except where the contrary is specially mentioned, insects included in this paper are from the Shiré Highlands.

Orthoptera.

Acridiidae.

There are two insects of this family which are really troublesome. In both cases they eat the leaves of young tobacco plants in the nurseries. The injury done is not really very great at any one time, but the aggregate damage during the season is fairly considerable. These two species are :—*Maura bolivari*, Kirby, and a species of *Chrotogonus*.

The other species are collectively destructive in varying degrees. In the planting season 1911–12 Acridiidae were very troublesome amongst freshly planted tobacco; in the present season 1912–13 their depredations were hardly noticeable. *Acrida turrita*, L., was an exception to the above statement, as it was committing a fair amount of havoc on an experimental plot of Turkish tobacco, in the Lower Shiré District. The brightly coloured *Zonocerus elegans*, Thunb., also occasionally becomes a minor pest.

The remaining species, so far as at present known, are :—*Catantops opulentus*, Karsch, *C. solitarius*, Karsch, *C. vittipes*, Sauss., *C. melanostictus*, Schaum, *Morphacris fasciatus*, Thunb., *Oedaleus citrinus*, Sauss., *Gastrimargus marmoratus*, Thunb., *G. wahlbergi*, Stål, *Acrotylus patruelis*, H.S., *Oxyrrhepes procera*, Burm., and *Acridium lineatum*, Stål.

Gryllidae.

Brachytrypes membranaceus, F., is sometimes troublesome in cotton fields from its habit of eating the roots of cotton plants. It is fairly common, but not a serious pest at present.

LEPIDOPTERA.

Lepidopterous larvae are the most destructive pests in the country, the three boll-worms being annually responsible for a tremendous amount of damage, and the NOCTUIDAE easily take first place, causing a greater loss to crops than any other family.

Noctuidae.

Diparopsis castanea, Hmp., (The Red Boll-worm) is a major pest of great importance and occurs all over the Protectorate.

Chloridea obsoleta, F., occurs everywhere in company with *Diparopsis castanea*, and besides destroying the bolls and flowers of cotton, attacks maize, tobacco seed-pods, and chick-peas.

Earias insulana, Boisd., occurs as a pest on cotton, but does not appear to be quite so serious as either of the foregoing, owing perhaps to the fact that it is heavily parasitised by an ichneumon. It has also been found on garden Hibiscus. It is generally distributed all over the Protectorate.

Euxoa segetum, Schiff., comes next in order of importance, and is an annually occurring pest which is responsible for much loss in the tobacco fields, during January and February, by cutting the stems of the plants.

Prodenia litura, F., is chiefly a pest in tobacco nurseries, but occurs also on cotton and maize and was once found feeding on tea. It is a fairly serious pest to young tobacco.

There is a number of Noctuid larvae which are all more or less harmful to cotton, by eating the leaves during the first stages of its growth until the appearance of the flowers. Their attacks last from December to the middle of March in the Shiré Highlands. The species include *Plusia orichalcea*, F., *Cosmophila erosa*, Hb., *Gonitis sabulifera*, Guen., *Plusia chalcites*, and *Acontia graellsii*, Feisth. *Busseola fusca*, Hmp., is one of the worst pests in Protectorate, causing a great annual loss in the native gardens by boring in the stems of maize and millet.

Pteronycta fasciata, Hmp. (gen. et sp. nov.) is at present very uncommon, but should it increase in numbers it would be capable of doing a great deal of damage. The larva when about to pupate eats half-way through the stem of a cotton plant and forms its cocoon in the place thus excavated. A very slight wind causes the cotton stems to break at the weakened part and the plant perishes.

Limacodidae.

Parasa vivida, Walk., is an occasional pest on coffee leaves and is very destructive when it does make its appearance.

Lymantriidae.

Heteronygmia leucogyna, Hmp., is a very serious and regular pest on mahogany (*Khaya senegalensis*). During the present year the mahogany plantations near Zomba were almost entirely defoliated by it.

Pyralidae.

Sylepta derogata, F. The cotton leaf-rolling caterpillar appears to be rare in the Shiré Highlands, at least in the Zomba District; further north, on the Lake shore, it is much more prevalent and is there a serious pest. The larvae are heavily parasitised by one of the CHALCIDIDAE.

Tineidae.

There are two species of TINEIDAE which are widely spread and destructive.

Phthorimaea heliopa, Lower, is a stem-borer of young tobacco, and is a very serious pest in the tobacco nurseries.

Gracilaria sp. nov.? The larva mines in the leaves of cotton and is a common insect, but is not very destructive, as healthy plants seem to be able to overcome its attacks without great difficulty. It would be a serious pest to cotton struggling against adverse conditions.

Nymphalidae.

Hypolimnas misippus, L., occurred once as a pest during last season, when in one cotton field the larvae were defoliating the plants. On this occasion they were present in large numbers, about a dozen feeding on a single plant at one time.

COLEOPTERA.

Only a few species of Coleoptera are, so far as the writer can tell at present, of any great economic importance. Certain species while very common on various crops are not particularly harmful.

Lagriidae.

Lagria villosa, F., is moderately destructive in vegetable gardens to leguminous plants, eating both flowers and leaves.

Galerucidae.

Ootheca mutabilis, Sahlb., occurs on cotton, leguminous crops and cucurbitaceous plants. It is especially destructive to the flowers of native pumpkins.

Diacantha conifera, Fairm., also occurs on cucurbitaceous and leguminous plants.

Asbecesta cyanipennis, Har., is destructive in the adult form to leguminous plants by eating the leaves. It is not, however, a very serious pest.

Pachytoma gigantea, Ill., was found to be troublesome in the nurseries of the Mlanje cypress plantations on the top of Zomba Mountain. It was committing a fair amount of damage by eating the growing points of the young trees.

Tenebrionidae.

Zophosis sp. is a very minor pest in the adult form on cotton and tobacco. *Gonocephalum simplex*, F., is also destructive in a slight degree in the tobacco fields.

Dermestidae.

Dermestes vulpinus, F., is a common household pest.

Meloidae.

Mylabris tricolor, Gerst., *M. amplectams*, Gerst., *M. dicincita*, Bert., *Decatoma catenata*, Gerst., are all destructive flower-eaters, occurring on cotton. *Ceroctis trifurca*, Gerst., eats the flowers of soya and velvet beans.

Curculionidae.

Apion armipes, Wagn. The larva bores in the stems of cotton plants, causing them to swell at the point of irritation and frequently to break at the first high wind. This is an insect with considerable powers of destruction, and apparently common all over the Shiré Highlands. *Calandra oryzae*, L., is very destructive to stored maize and rice. A species of *Isaniris* is a general, but not very destructive, pest on cotton, the adult form eating the leaves.

Coccinellidae.

Epilachna dregei, Muls., *E. hirta*, Thunb., and *E. paykulli*, Muls., are all major pests in vegetable gardens. *Chilomenes lunata*, F., preys on the cotton aphis, and is an extremely useful insect.

Cassididae.

Cassida gibbipennis is a minor pest on leguminous plants.

Nitidulidae.

Epuraea sp. has been found eating the stamens of cotton flowers ; a minor pest.

Ptinidae.

Lasioderma serricorne, F., bores in cigars and cigarettes.

HYMENOPTERA.

Tenthredinidae.

Athalia sp. A major pest on turnips and cabbages ; a very destructive species.

RHYNCHOTA.

Aphididae.

There appear to be four species of APHIDIDAE which may be accounted pests of some importance.

Aphis gossypii, Glover, is very troublesome on cotton in certain seasons, especially those marked by excessive rainfall. There are two other species which are very destructive to cabbages and beans respectively. The former (*Aphis brassicae*, L.) is covered with a waxy secretion which adds to the difficulty of its extermination by means of contact poisons. The Bean Aphis is a dark green species with the legs banded with white. The fourth species, *Cerataphis lataniae*, Newst., was found on *Raphia vinifera* in the Botanical Gardens at Zomba.

Coccidae.

Pulvinaria jacksoni, Newst., occurs occasionally on cotton, but in small numbers.

Coreidae.

Anoplocnemis curvipes, F., causes a certain amount of injury to cotton plants in some districts by sucking the stems. It has been found puncturing the young tender shoots of mahogany in the plantations near Zomba.

Pentatomidae.

Antestia variegata, Thunb., damages coffee berries to a considerable extent. *Atelocera stictica*, Westw., sucks the new shoots of mahogany.

Pyrrhocoridae.

Dysdercus nigrofasciatus, Stål, is a major pest of cotton, which it damages both by sucking the seeds and by staining the lint. It is generally distributed in the Protectorate. *Odontopus confusus*, Dist., attacks cotton in the same way, but appears to be more limited in its distribution, occurring only in the low-lying hot districts.

COLLECTIONS RECEIVED.

The thanks of the Imperial Bureau of Entomology are due to the following gentlemen, who have kindly presented collections of insects (received between 1st July and 30th September, 1913):—

Dr. W. M. Aders:—7 Culicidae, 50 *Tabanus*, 3 other Diptera, 9 Lepidoptera, 15 Coleoptera, 4 spp. of Coccidae, and 3 other Rhynchota; from Zanzibar.

Mr. E. Ballard, Government Entomologist:—5 Tabanidae, 10 other Diptera, 49 Lepidoptera, 97 Hymenoptera, 89 Hymenopterous egg-parasites, 58 Coleoptera, a number of Coccidae, about 100 Aphididae, some eggs of *Phonoctonus*, 25 other Rhynchota, 33 Termites, and 33 Orthoptera; from Nyasaland.

Mr. W. P. B. Beal, Veterinary Officer:—5 *Tabanus* and 6 *Glossina*; from Ashanti.

Dr. F. J. A. Beringer, Medical Officer of Health:—30 Culicidae; from Cape Coast Castle, Gold Coast.

Mr. G. E. Bodkin, Government Economic Biologist:—9 *Chrysops*, 24 other Diptera, 188 Hymenoptera, 93 Coleoptera, 88 Termites, numerous Coccidae, 21 other Rhynchota, 4 Orthoptera, and 4 Centipedes; from British Guiana.

Dr. L. H. Booth, W.A.M.S.:—19 *Ceratopogon*, 62 Culicidae, 1 *Tabanus*, 3 *Glossina*, 11 *Stomoxys*, 33 other Diptera, 6 Hymenoptera, 6 Coleoptera, 57 Lepidoptera, 2 Planipennia, 4 Orthoptera, 5 Rhynchota, and 2 Trombidiidae; from Yaba, Southern Nigeria.

Dr. R. Bury, Medical Officer:—21 Culicidae, 22 Tabanidae, 27 *Glossina morsitans*, 1 *Auchmeromyia*. and 13 other Diptera; from Nyasaland.

Dr. W. F. Campbell, W.A.M.S.:—8 *Haematopota*, 14 *Tabanus*, 10 *Glossina palpalis*, 1 other Dipteron, and 1 Hymenopteron; from Tesani, Sierra Leone.

Dr. W. S. Clarke, W.A.M.S.:—32 Culicidae, 61 *Tabanus*, 9 *Glossina palpalis*; from Southern Nigeria.

Dr. J. Currie, W.A.M.S.:—75 Coleoptera and 5 Rhynchota; from Calabar, Southern Nigeria.

Mr. E. Dayrell, District Commissioner:—1 *Rhinomyza stimulans*, 40 *Chrysops*, 30 *Tabanus*, 29 *Glossina*, 4 other Diptera, and 2 Hymenoptera; from Ahoada, Southern Nigeria.

Dr. R. E. Drake-Brockman:—215 Ticks (*Ornithodorus savignyi*); from British Somaliland.

Dr. Mercier Gamble:—13 Culicidae, 14 *Simulium*, 3 *Haematopota*, 30 *Tabanus*, 1 *Cordylobia*, 15 other Diptera, 1 Orthopteron, and a species of Coccidae; from the Congo.

Mr. B. S. Gledhill:—2 *Haematopota*, 1 *Tabanus*, 1 *Glossina*, 3 Hymenoptera, 14 Coleoptera, and 5 Rhynchota; from Uganda.

Dr. Lewis H. Gough, Government Entomologist:—1 *Culex*, 3 *Tabanus*, 4 Hippoboscidae, 3 other Diptera, 3 Hymenoptera, 14 Lepidoptera, 7 Orthoptera, and 6 Rhynchota; from Egypt.

Mr. A. R. Gould:—2 Tabanidae, 2 *Glossina*, 61 other Diptera, 24 Hymenoptera, 97 Coleoptera, 32 Lepidoptera, 3 Planipennia, 5 Orthoptera, 77 Rhynchota, 3 Odonata, 1 Trombidiid, and 10 Spiders; from the Gold Coast.

Mr. C. C. Gowdey, Government Entomologist:—18 Diptera, 30 Fleas, 492 Hymenoptera, 743 Coleoptera, 4 Lepidoptera, 1 Biting Louse, 20 Thrips, 2 Cimicidae, a number of Coccidae, 779 other Rhynchota, 335 Orthoptera, 38 Ticks, 10 Mites, and 3 Mollusca; from Uganda.

Dr. H. Hearsey, Principal Medical Officer:—32 Rhynchota; from Nyasaland.

Mr. E. Hutchins, Chief Veterinary Officer:—17 *Haematopota*; from Uganda.

Dr. A. Hutton, W.A.M.S.:—63 *Glossina longipalpis*, 223 *G. palpalis*, and 3 other Diptera; from Abokobi, Gold Coast.

Imperial Department of Agriculture, West Indies:—5 Diptera, 8 Coleoptera, 15 Termites, 10 Rhynchota, and a number of Mites; from the British West Indies.

Dr. A. Ingram, W.A.M.S.:—33 adult Culicidae, 18 Culicid pupae, 15 Culicid larvae, 23 *Phlebotomus*, 11 Tabanidae, 55 *Glossina*, and 8 other Diptera; from Kintampo, Ashanti.

Mr. J. C. Kershaw:—The Type and another specimen of *Tomaspis carmodyi* (Cercopidae); from Trinidad.

Mr. Chas. H. Knowles, Superintendent of Agriculture;—Mites found in the mines of *Promecotheca reichii* (Coleoptera); from Fiji.

Dr. W. A. Lamborn, Government Entomologist:—1 *Simulium*, 1 *Phlebotomus*, 1 *Hippocentrum*, 2 *Tabanus*, 145 other Diptera, 288 Hymenoptera and some Hymenopterous cocoons, 1013 Coleoptera, 25 Lepidoptera, 50 Termites, a number of Coccidae, 32 other Rhynchota, and 2 Orthoptera; from Ibadan, Southern Nigeria.

Mr. Ll. Lloyd, Government Entomologist:—3 *Haematopota*, and 2 *Tabanus*; from North-eastern Rhodesia.

Capt. A. O. Luckman, Assistant District Commissioner:—8 Culicidae, 1584 Lepidoptera, 3 Planipennia, 145 Rhynchota, 34 Orthoptera, 13 49 *Haematopota*, 232 other Diptera, 250 Hymenoptera, 286 Coleoptera, 13 Odonata, 36 Ticks, 31 other Arachnida, and some Snakes; from the Masai Reserve, British East Africa.

Dr. A. Lundie, W.A.M.S.:—111 Culicidae; from Bole, Northern Territories.

Mr. R. MacDonald, Controller of Customs:—2 Larvae, 1 pupa, and 1 adult of *Cordylobia anthropophaga*; from Chiromo, Nyasaland.

Dr. J. W. Scott Macfie, W.A.M.S.:—3 *Culicoides*, 33 Culicidae, about 50 *Simulium*, 3 *Tabanus*, 2 *Glossina*, 38 *Stomoxys*, 40 other Diptera, 2 Hymenoptera, 2 Coleoptera, 54 Lepidoptera, 2 Planipennia, 5 Mallophaga, 2 Rhynchota, 4 Orthoptera, 3 Odonata, 1 Mite, and 1 Worm; from Southern Nigeria.

Dr. C. H. Marshall, M.O.:—24 *Haematopota*, 15 *Tabanus*, 18 *Glossina*, 2 *Stomoxys*, 2 *Auchmeromyia*, 3 *Hippobosca*, 47 other Diptera, 12 Hymenoptera, 413 Coleoptera, 1 Lepidopteron, 1 Myrmeleonid, 178 Rhynchota, and 11 Orthoptera; from Uganda.

The Medical Research Institute, Yaba, near Lagos:—189 Culicidae, 2 *Chrysops*, 3 *Hippocentrum*, 41 *Tabanus*, 21 *Glossina*, 13 *Stomoxys*, 3 *Auchmeromyia*, 3 Hippoboscidae, 84 other Diptera, 1 Hymenopteron, 7 Coleoptera, 3 Rhynchota, and 5 Orthoptera; from Southern Nigeria.

Dr. J. G. Morgan, M.O.:—12 Culicidae, 25 *Haematopota*, 5 *Tabanus*, 4 *Stomoxys*, 2 *Cordylobia*, and 22 other Diptera; from Lake Nyasa, Nyasaland.

Mr. S. A. Neave:—2 *Culicoides*, 109 Culicidae, 1 *Simulium*, 93 *Dorcaloemus*, 37 *Chrysops*, 66 *Haematopota*, 47 *Tabanus*, 134 *Glossina*, 9 *Stomoxys*, 191 cases of Asilidae and their prey, 248 examples of prey of *Promachus fasciatus*, 264 Dipterous parasites reared from Lepidopterous hosts, 332 other Diptera, 2961 Hymenoptera, 13 tubes of parasitic Hymenoptera in spirit, 645 Hymenopterous parasites bred from Lepidopterous hosts, 4356 Butterflies, 5652 Moths, 1 Caddis-fly, 3798 Coleoptera, 6 Planipennia, 5 Cimicidae, 2 species of Coccidae, a number of Aphididae, 1853 other Rhynchota, 111 Orthoptera, 18 Ticks, 1 Spider, and 1 Worm; from Mlanje, Nyasaland.

Dr. J. E. S. Old, M.O.:—119 Culicidae, 3 Hymenoptera, 2 Coleoptera, 2 Rhynchota, and 1 Orthopteron; from Port Herald, Nyasaland.

Mr. A. Rutherford, Government Entomologist:—5 Diptera, 9 Coleoptera, 21 slides of Chalcididae, 1 Ant, 3 Lepidoptera, 16 slides of Thrips, 1 species of Coccidae, 10 other Rhynchota, 2 Orthoptera, 3 Ticks, and 2 slides of Mites; from Peradeniya, Ceylon.

Dr. Samuel Shepheard:—5 Tabanidae; from Colombia, South America.

Mr. H. Silberrad, District Resident:—6 *Haematopota* and 28 *Tabanus*; from Nyasaland.

Dr. Jas. J. Simpson:—26 Culicidae, 1 *Simulium*, 5 *Haematopota*, 10 *Hippocentrum*, 42 *Tabanus*, 378 *Glossina*, 5 Hippoboscidae, 58 other Diptera, 229 Hymenoptera, 54 Coleoptera, 84 Lepidoptera, 24 Rhynchota, 12 Orthoptera, 29 Odonata, 7 Ticks, 3 Spiders, and a tube of Feather-eating Mites; from the Gold Coast.

Dr. B. Spearman, M.O.:—4 *Haematopota*, 12 *Glossina*, and 2 Trombidiidae; from Uganda.

Dr. H. S. Stannus, M.O.:—28 Culicidae, 3 Culicid larvae, 1 Culicid pupa, 30 *Simulium*, 2 *Holcoceria*, 1 *Chrysops*, 1 *Haematopota*, 10 Psychodidae, 2 Oestrid larvae, 69 other Diptera, 2 Hymenoptera, 52 Coleoptera, 2 Lepidoptera, 187 Rhynchota, 3 Orthoptera, and 29 Ticks; from Zomba, Nyasaland.

Dr. H. Swale:—16 Termites, 1 Pentatomid Bug, and 3 Spiders; from Southern Rhodesia.

Mr. F. W. Urich, Entomologist to the Board of Agriculture:—7 Melolonthid Beetles; from Trinidad, British West Indies.

Dr. W. M. Wade, W.A.M.S. :—1 *Rhinomyza stimulans* and 13 *Glossina longipalpis* ; from the Gold Coast.

Dr. John Y. Wood, W.A.M.S. :—154 Culicidae, 100 Culicid larvae, 25 Culicid pupae, and several Culicid eggs, 34 *Hippocentrum*, 53 *Haematopota*, 60 *Tabanus*, and 237 *Glossina* ; from Sierra Leone.

Mr. R. C. Wood, Assistant Agriculturist :—4 Culicidae, 1 *Pangonia*, 1 *Dorcaloemus*, 2 *Haematopota*, 4 *Tabanus*, a new genus and species of Tabanidae, 4 *Stomoxys*, 4 *Auchmeromyia*, 176 other Diptera, 3 Coleoptera, 3 Rhynchota, and 1 Tick ; from Northern Rhodesia.

GENERAL INDEX.

The numerals in heavy type indicate that the species to which they refer is figured.

INDEX TO NAMES OF PERSONS.

INDEX TO PLANTS ATTACKED BY INSECTS.

ERRATA.

P. 65, line 25, for "*gemmatalis*" read "*gemmatilis.*"

P. 69, legend —, for "Fig. 2. *Dactylopius obtusus*, Newst.," read "Fig. 6. *Ceroplastes coniformis*, Newst."

P. 72, legend —, for "Fig. 6. *Ceroplastes coniformis*, Newst.," read "Fig. 2. *Dactylopius obtusus*, Newst."

P. 155, line 29, for "*Rapha*" read "*Raphia.*"

P. 179, line 28, for "(see p.)" read "(see p. 173)."

P. 244, line 27, for "*Miscrosporidium*" read "*Microsporidium.*"

P. 249, line 5, for "*C. punctata*" read *C. punctatus.*"

P. 249, line 26, for "*trilobiformis*" read "*trilobitiformis.*"

P. 269, line 19, for "Somoa" read "Samoa."

Plates XXIX., XXX., and XXXI., for "Bull. Ent. Research. Vol. IV. Part 3, read "Bull. Ent. Research. Vol. IV. Part 4."

P. 314, line 5, for "*aurantiae*" read "*aurantii.*"

P. 321, line 34, for "Indes" read "Indies."

P. 325, line 11, for "*aurantiae*" read "*aurantii.*"

P. 350, line 4, for "*amplectams*" read "*amplectens.*'

LONDON:
PRINTED UNDER THE AUTHORITY OF HIS MAJESTY'S STATIONERY OFFICE
By BARCLAY AND FRY, LTD., SOUTHWARK, S.E.

1914.